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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2016

J250/10 Summer 2019 series

Version 1

Contents

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

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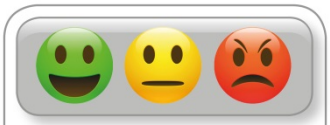

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Paper 10 series overview

J250/10 is the second of two higher papers assessing chemistry in the Combined Science A suite. The other four papers in the suite assess biology and physics. This paper assesses content from topics C4–C6 and CS7, with assumed knowledge of C1–C3. This is the second time this qualification has been assessed. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques. There is also an emphasis on knowledge and understanding of the assessment objectives from the specification.

It is important that candidates understand the command words and what is expected when a particular command word is used. In some cases, descriptions were given when explanations were needed and so not all marks were accessed. Exam practice is essential so that candidates understand the requirements of a paper. It is good to see that the candidates are reading the Maths style questions correctly and recognising where specific number of decimal places or significant figures are needed.

Candidates who did well on this paper generally	***Candidates who did less well on this paper generally***
• Read the question carefully and used all information given • Knew basic scientific principles and terminology and used them correctly • Were able to interpret data from tables and graphs • Had carried out relevant practical's • Were able to plan investigations • Were able to analyse information and evaluate plans • Were able to balance equations correctly • Were able to use data correctly to perform calculations and show working, including giving answers to correct decimal places or significant figures • Understood the factors that affect rate and equilibrium	• Did not read the questions carefully and did not use all the information provided • Did not use correct terminology • Could not write correct balanced equations • Could not evaluate a plan and did not understand the difference between independent and dependent variables • Struggled to interpret data from tables and graphs • Could not explain the factors that affect rate or equilibrium • Did not show working for calculation questions

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Section A overview

Multiple choice questions were generally well answered.

Questions 1, 2, 3, 6 and 9 were well answered by most candidates; questions 4, 5, 7 and 8 were less well answered and candidates found question 10 challenging.

It is important that the question and all possible answers are read carefully.

Question 4

4 Which statement explains why methane is a greenhouse gas?

A It absorbs and re-emits infrared radiation.

B It absorbs and re-emits ultraviolet radiation.

C It contains carbon.

D It is released into the atmosphere by cattle.

Your answer ☐ **[1]**

Candidates often gave B as an answer showing a lack of understanding of the greenhouse effect.

Question 5

5 Manganese dioxide, MnO_2, can act as a catalyst.

A student mixes 10 g of MnO_2, a black solid, with 4 different solutions, **A**, **B**, **C** and **D**.

With which solution does MnO_2 act as a catalyst?

	Does a chemical reaction happen?	After mixing
A	No	10g of black solid left
B	Yes	10g of black solid left
C	Yes	more than 10g of green solid left
D	Yes	more than 10g of pink solid left

Your answer ☐ **[1]**

The less able candidates showed they did not know how a catalyst behaves during a reaction. C was a common wrong answer.

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Question 7

7 Aluminium is extracted by electrolysis.

Iron is extracted by reduction with carbon.

Which row of the table **explains both** facts?

A	aluminium is more reactive than carbon	carbon is more reactive than iron
B	aluminium is more reactive than carbon	iron is more reactive than carbon
C	aluminium is more reactive than iron	carbon is more reactive than iron
D	aluminium is more reactive than iron	iron is more reactive than carbon

Your answer ☐ **[1]**

C was a common wrong answer, showing that candidates either do not understand or were not reading the information correctly.

Question 8

8 This question is about the elements in Group 1.

Which row of the table is correct?

	Reactivity	Reason
A	decreases down the group	it is easier to form positive ions
B	decreases down the group	it is easier to form negative ions
C	increases down the group	it is easier to form positive ions
D	increases down the group	it is easier to form negative ions

Your answer ☐ **[1]**

This question needed reading carefully.

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Question 10

10 Chlorine is in Group 7 of the Periodic Table.

What is the mass of 2 moles of chlorine gas?

A 35.5g

B 71.0g

C 106.5g

D 142.0g

Your answer ☐ **[1]**

Most candidates did not score here. Many gave B as an answer, clearly not realising that 2 moles were present.

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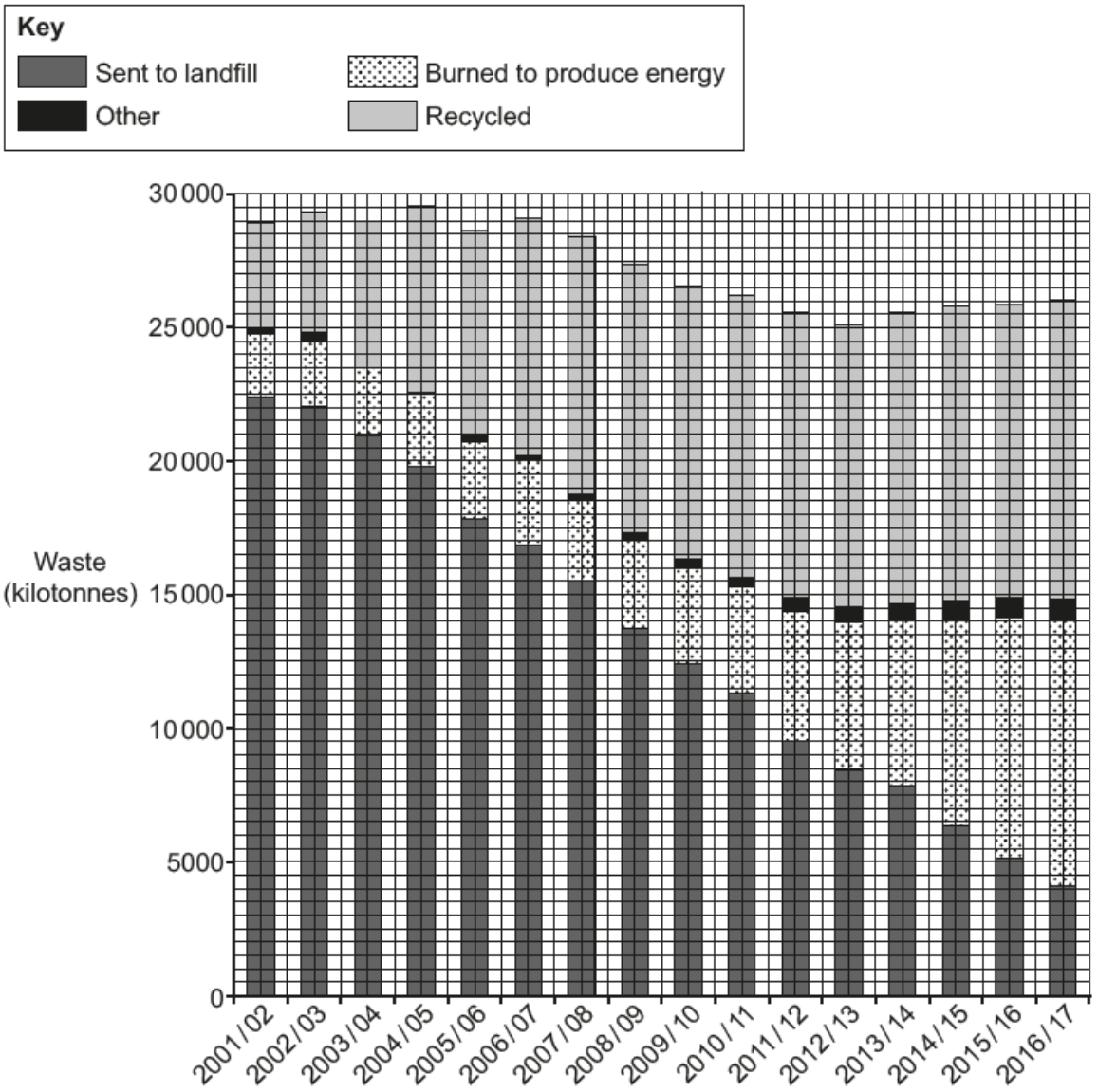
Section B

Question 11 (a)

11 Local councils collect waste from households.

The graph shows what happened to the waste between 2001 and 2017.



(a) Describe **and** explain **one** trend shown by the graph.

.....

.....

.....

..... **[2]**

Most candidates gained one or 2 marks here. Candidates needed to interpret the information on the graph. A good answer mentioned more than one treatment of waste and related them to each other.

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Question 12 (a)

12 A student adds some magnesium to dilute hydrochloric acid (HCl).

Magnesium chloride ($MgCl_2$) and hydrogen gas is formed.

(a) Write a **balanced** symbol equation for this reaction.

..... **[2]**

The most common mistake here was not knowing the formula for hydrogen. The candidate could not then gain a balancing mark as it is not possible to balance incorrect formula.

Question 12 (b) (i)

(b) She wants to investigate how changing the concentration of hydrochloric acid affects the rate of reaction.

The student uses:

- hydrochloric acid with a concentration of 1 mol / dm^3
- magnesium ribbon
- a conical flask
- a measuring cylinder
- a mass balance
- a stopwatch.

(i) Identify the independent variable in the investigation.

..... **[1]**

The expected answer was concentration. Just stating 'hydrochloric acid' was not sufficient. Some candidates wrote out 'hydrochloric acid with a concentration of 1 mol / dm^3' This did not gain credit as it did not show that they knew the concentration had to change.

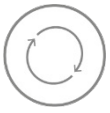
Question 12 (b) (ii)

(ii) Identify **two** control variables in the investigation.

1 .....

2 .....

[2]

	**AfL**	Many candidates gave apparatus items from the list in the question. this showed they had either not read it correctly or they did not know what a variable is. It is important for every practical candidates carry out that they are aware of all the variables involved.

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Question 12 (c)

(c) The student measures the time it takes from adding the magnesium to the hydrochloric acid until the reaction mixture stops bubbling.

The table shows the student's results.

Concentration of acid (mol/dm^3)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Mean (average) time (s)
1.00	15	15	15	15
0.75	65	55	41	54
0.50	85	90	88	88
0.25	300	290	295	295

The results at 0.75 mol/dm^3 are **not** precise.

Suggest **one** reason why this might have happened.

.....

..... **[1]**

Many candidates got a mark here. 'Human error' was not credited unless the candidate specified the type of error, e.g. starting a stopwatch at the wrong time.

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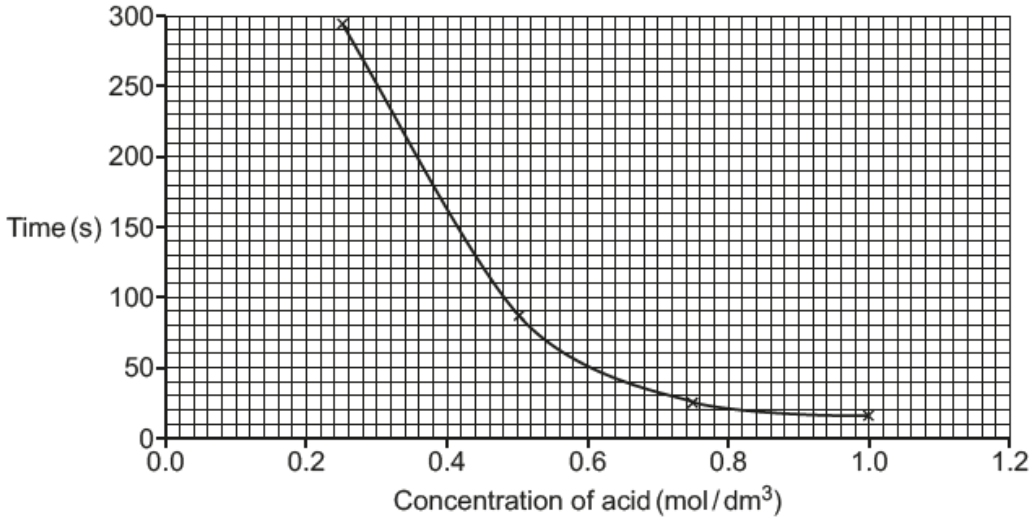
Question 12 (d)

(d) The results at 0.75 mol/dm^3 are repeated.

This is a graph of the student's results.



What conclusion can you make from these results?

Include ideas about **particles** in your answer.

.....

.....

.....

.....

.....

.....

..... **[3]**

Most candidates only got one or 2 marks here. Some thought that higher concentration meant particles had more energy and so showed a lack of understanding. They knew the question was about rate and tried to answer in terms of temperature and energy rather than reading the question properly and answering the question as set.

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Exemplar 1

As the concentration of hydrochloric acid increases, the rate of reaction also increases because the time taken for the reaction to finish decreases. For example, at first it took 160 seconds for the reaction to finish when the concentration of acid was 0.4 mol/dm^3, whereas at 0.6 mol/dm^3, the reaction took 50 seconds. This is because when the concentration is increased, there are more particles to collide with each other, meaning that the frequency of collisions will be higher, leading to more successful collisions which increases the rate. ✓ [3]

In Exemplar 1 the candidate has gained mark point 1 as they had the correct relationship between concentration and rate. They did not gain mark point 2. They said there were more particles but did not state 'in the same volume'. This was a common error and many candidates lost this mark. They went on to gain mark point 3 for frequency of collisions being higher. Many candidates lost this mark because they stated there were more collisions but did not make it clear this was in the same time or they were more frequent.

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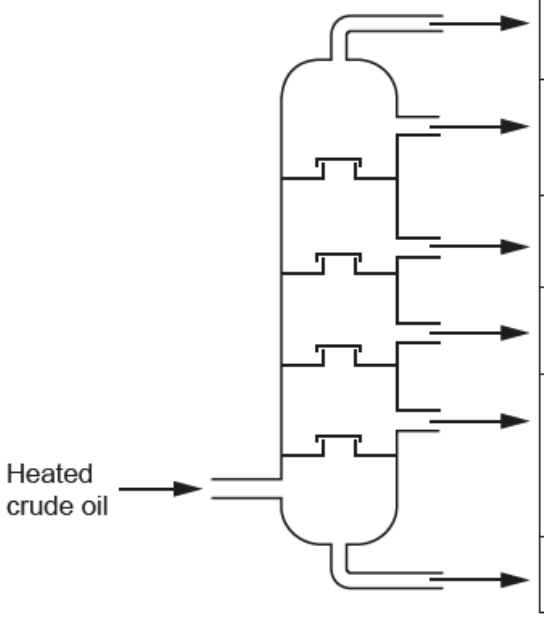
Question 13

13* Fractional distillation can be used to separate different fractions from crude oil.

Fig. 13.1 and **Fig. 13.2** give some information about the process.



Fraction	Average number of carbon atoms in alkanes present in fraction
LPG	3
Naphtha	10
Kerosene	15
Gas oil	20
Lubricating oil	35
Residue	40

Fig. 13.1

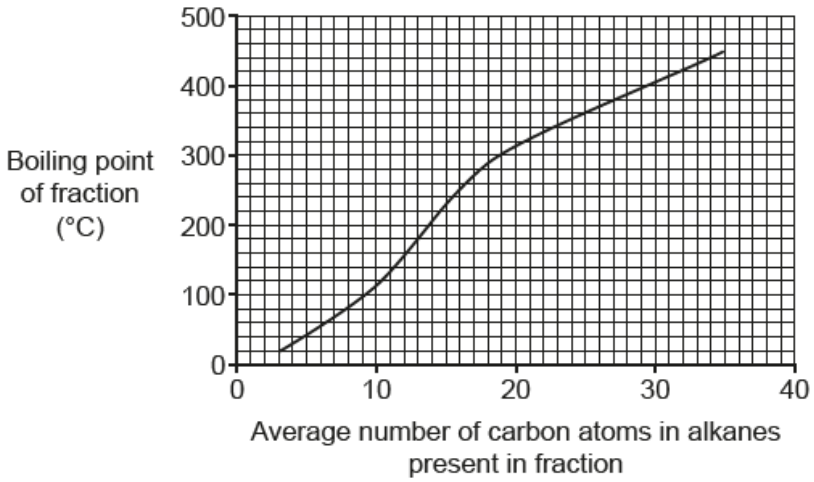


Fig. 13.2

Explain how fractional distillation produces the different fractions from crude oil.

Use the information in **Fig. 13.1** and **Fig. 13.2** in your answer.

.....

..... **[6]**

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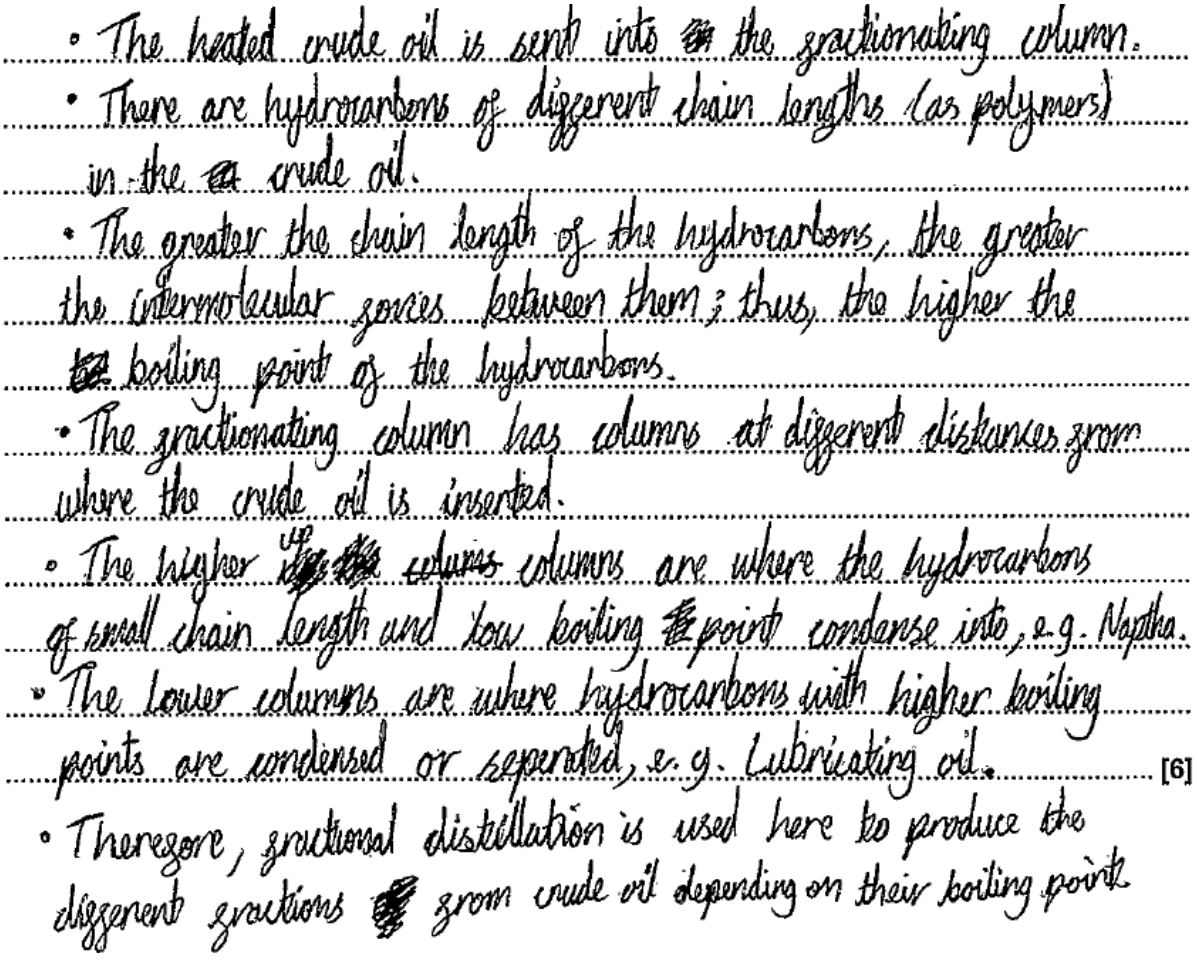
Most candidates were able to access this question gaining at least 1 mark. Interpretation of data in graph was poor (some just quoted numbers of carbons or boiling points without identifying trends or linking) and idea of intermolecular forces not well understood. There was some confusion between melting and boiling point. Level 2 was usually given as candidates used data given to suggest links between boiling point/ carbon chain and position in column. Intermolecular forces were often omitted or confused with breaking covalent bonds within the molecule. As a consequence, several candidates described the principle of 'cracking'. Some thought that as molecules went up the column as they were being broken down into smaller molecules. Candidates that understood the effect of intermolecular forces usually gave Level 3 answers. To gain Level 2 or 3 candidates had to link the ideas together. Level one answers would only have simple statements such as different alkanes have different length carbon chains.

Exemplar 2



- The heated crude oil is sent into the fractionating column.
- There are hydrocarbons of different chain lengths (as polymers) in the crude oil.
- The greater the chain length of the hydrocarbons, the greater the intermolecular forces between them; thus, the higher the boiling point of the hydrocarbons.
- The fractionating column has columns at different distances from where the crude oil is inserted.
- The higher columns are where the hydrocarbons of small chain length and low boiling point condense into, e.g. Naptha.
- The lower columns are where hydrocarbons with higher boiling points are condensed or seperated, e.g. Lubricating oil. [6]
- Therefore, fractional distillation is used here to produce the different fractions from crude oil depending on their boiling point

In Exemplar 2 the candidate links boiling point, chain length, intermolecular forces and position in column so fully answers the question for 6 marks.

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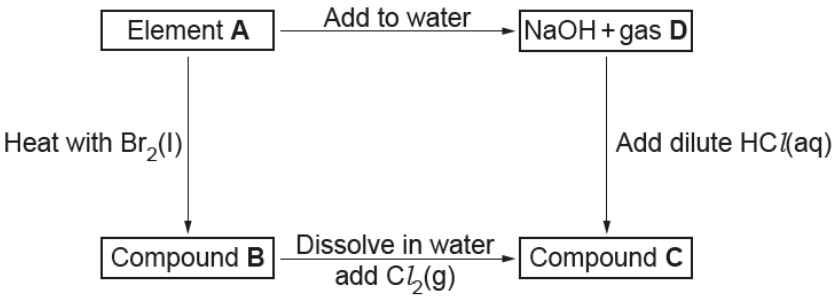
Question 14 (a), (b) (i), (b) (ii), (c) (i) and (c) (ii)

14 Some Group 1 and Group 7 elements are very reactive.

Look at the reaction cycle.



(a) Identify element **A**.

..... **[1]**

(b) (i) Identify compound **B**.

..... **[1]**

(ii) Write a balanced equation for the reaction of element **A** with $Br_2(l)$.

Include state symbols in your answer.

..... **[2]**

(c) (i) Identify compound **C**.

..... **[1]**

(ii) Give a reason for your answer to **(c)(i)**.

.....

..... **[1]**

Candidates in general could interpret the diagram to give sodium for 14(a). Most could then give the correct answer to (b)(i). A common error here was to give the formula incorrectly. The name of the elements and compounds was sufficient for (a), (b)(i) and (c)(i). However, if the candidate chose to give the formula instead, they had to give the correct formula. Many lost the mark for (b)(i) as they gave the formula incorrectly as $NaBr_2$. This often led to the incorrect formula being used in the equation for (b)(ii). Very few got the state symbols correct. When state symbols were included the most common error was quoting NaBr as (aq).

Many candidates understood either the reactivity series of the halogens or the idea of displacement reaction with some even linking the two ideas. Very few mentioned the idea of neutralisation. Some lost this mark because the confused bromine and bromide.

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Question 14 (d)

(d) **D** is a colourless gas.

How can you show if the gas is carbon dioxide, hydrogen or oxygen?

Describe the tests for carbon dioxide, hydrogen and oxygen and the results you would expect with gas **D**.

test for carbon dioxide .....

.....

result with gas **D** .....

test for hydrogen.....

.....

result with gas **D** .....

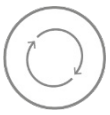
test for oxygen .....

.....

result with gas **D** .....

[3]

This question was not well answered, in spite of the formatting of the question. Very few candidates considered the effect of the test on gas D. Many students could identify the tests required for the gases but did not identify the result with gas D or confused the different tests with each other. Some very odd tests (e.g. litmus) were given for CO_2. Many omitted the details of the test for hydrogen - the test being referred to as 'the squeaky pop test' without mentioning the lighted splint. Many stated that the splint should be blown out in the oxygen test. This would not work and so could not be credited. Many misread the question and just gave the tests and results not the results for gas D. So many put "if …." Not many got all 3 marks. 1 mark was mostly gained for having the correct test and result for hydrogen.

	**AfL**	The science in this question is familiar to most candidates from key stage 3. However, this question wanted them to apply their knowledge to a specific gas. Most did not do this. This shows a lack of practice in applying knowledge. Candidates should be given opportunities to apply their knowledge in unfamiliar contexts as often as possible.

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Question 15 (a)

15 The reaction between sulfur dioxide and oxygen is reversible.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ energy change = –198 kJ / mol

(a) The table shows some relative atomic masses.

Element	Relative atomic mass
sulfur	32.1
oxygen	16.0

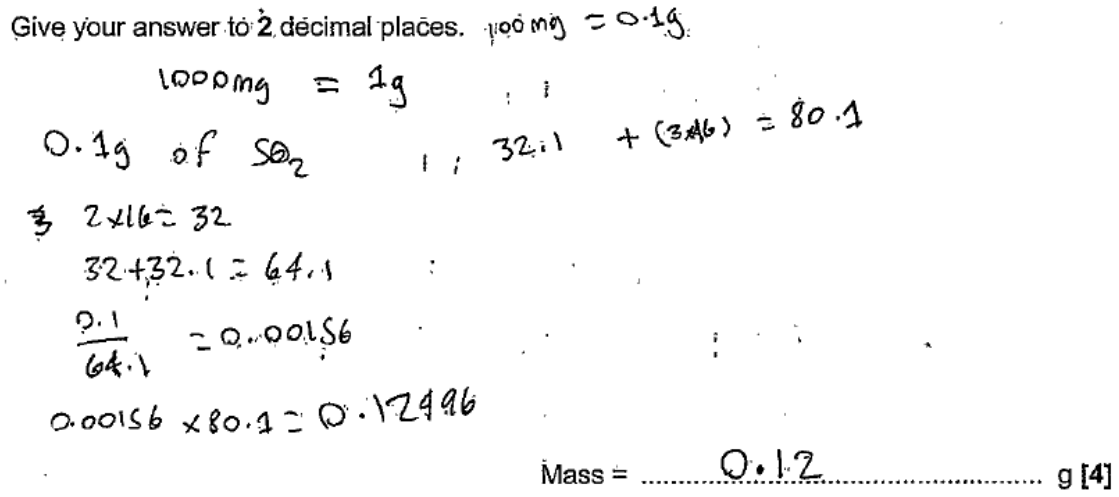
Calculate the maximum mass of SO_3, in g, that can be made from 100 mg of SO_2.

Give your answer to **2** decimal places.

Mass = ... g **[4]**

Candidates found this question challenging with most only gaining one mark for calculating one of the relative molecular masses. Higher ability candidates understood the need to find a ratio, but this was sometimes inverted. Conversion from mg to grams was not well done – often out by powers of 10. There were instances of candidates using the energy change in calculations. Most knew how to give the answer to 2 decimal places.

Exemplar 3



In Exemplar 3 the candidate has shown his working for each step. They have gained the full 4 marks. However, if there had been an error at any stage it would have been possible to award marks for any correct step as the examiner could follow the working.

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Question 15 (c) (i) and (c) (ii)

(c) (i) When the reaction between sulfur dioxide and oxygen is at equilibrium, what is the effect of increasing the temperature?

Explain your answer.

.....

.....

..... **[2]**

(ii) When the reaction between sulfur dioxide and oxygen is at equilibrium, what is the effect of increasing the pressure?

Explain your answer.

.....

.....

..... **[2]**

Many candidates gained the first mark for each question. However, they struggled to explain why the position of equilibrium moved. Many tried to answer in terms of rate of reaction. There were similar questions on the June 18 paper and many candidates may have practised these. However, those questions could have been answered in terms of rate or position of equilibrium. These questions could only be answered in terms of position. Candidates need to read the question carefully.

Question 15 (d) (i)

(d) (i) Write down **two** sources of sulfur dioxide in the atmosphere.

1 .....

2 .....

[1]

"Volcanoes" was a fairly common answer but, surprisingly, few mentioned petrol or diesel etc. Many responses seen demonstrated a distinct lack of understanding. Stating 'industry' or 'vehicles' alone was not specific enough to gain the mark.

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Question 15 (d) (ii)

(ii) Describe **two** problems caused by the release of sulfur dioxide into the atmosphere.

1 .....

.....

2 .....

.....

[2]

The effects were not well known with many references to global warming, ozone layer and climate change. Those giving the formation of acid rain did not extend their responses to its effects. The answer had to have a problem and acid rain without its effects was insufficient.

It was fairly common to see idea of damage to various living things/habitats to gain a mark. Some also mentioned respiratory problems. Damage to buildings etc was less common, and corrosion of metals hardly ever seen.

Question 16 (a)

16 One homologous series of organic compounds is called the alkanes.

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

Methane (n = 1) and ethane (n = 2) are the first two alkanes.

Write down their chemical formulae.

methane.....

ethane.....

[1]

This question was generally answered well. C_1H_4 was accepted this time but it should be made clear to candidates that the '1' is not necessary in the formula for methane.

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Question 16 (b) (i)

(b) This table shows the energy released when one mole of an alkane is completely burned in oxygen.

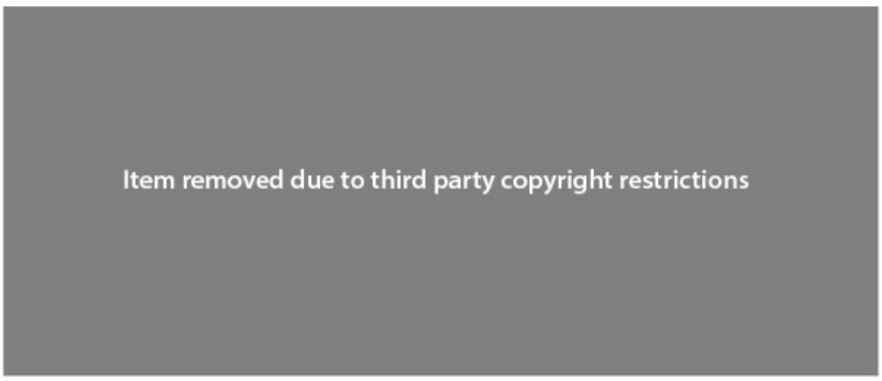
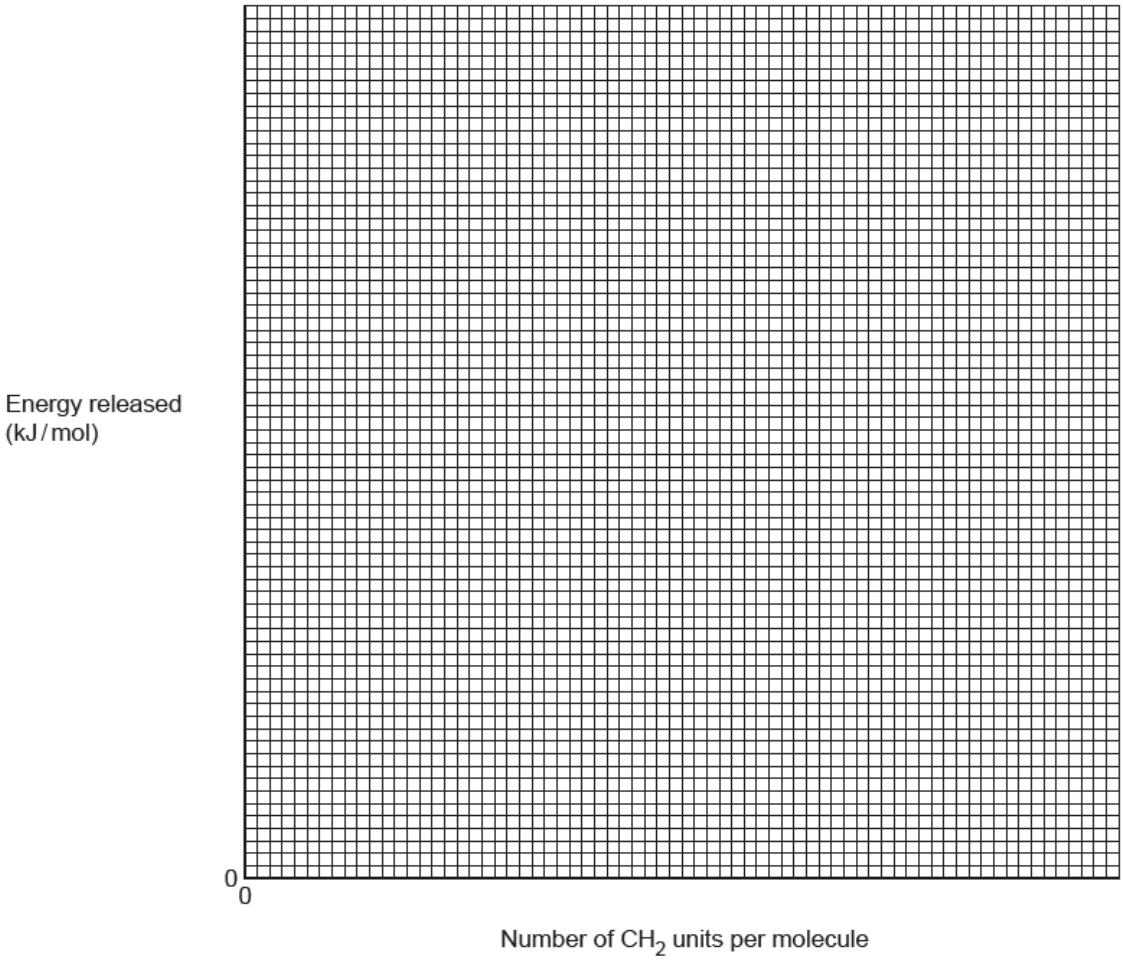


Table 16.1

(i) Plot a graph using the data in **Table 16.1** and draw a line of best fit.
Use the axes below.



[2]

Most candidates have good graph plotting skills. Some unusual scales were chosen, and candidates should practice choosing scales as it helps them produce better graphs. It was acceptable to use an axis break on the y-axis. However, in some cases candidates positioned a plot within the axis break and so it was not clear what energy release was being plotted. This lost the plotting mark. Some candidates also forced their line of best fit through the origin. This showed a lack of understanding of the data being plotted and lost the line of best fit mark.

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Question 16 (b) (ii)

(ii) Calculate the gradient (slope) of the graph.

Gradient = ... (kJ / mol / CH_2 unit per molecule) **[2]**

Candidates found this question challenging with change in x causing a particular problem. Many did not state or reference values on y-axis. Best marks were gained when students used differences between plotted points i.e. data given. Some just wrote down a number and didn't show how they had got to it. The first mark was for showing an understanding of how the gradient is calculated so those who showed their working or wrote out the formula were more likely to gain at least one mark.

Question 16 (b) (iii)

(iii) Estimate the energy released when decane ($C_{10}H_{22}$) burns.

Use your answer to **(b)(ii)** to help you.

Energy released = ... kJ / mol **[2]**

Only the higher ability candidates tended to score here. A fairly common error was failing to appreciate that decane had two more CH_2 groups than octane so they needed to add 2x gradient to the value for octane. Another fairly common error was just multiplying the gradient by 10.

A few candidates actually used the standard equation y = mx + c to arrive at the right answer.

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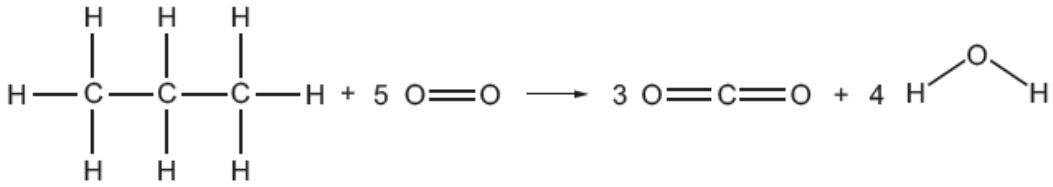
Question 16 (c)

(c) Propane burns in oxygen to form carbon dioxide and water.



The table shows some bond energies.

Bond	Bond energy (kJ / mol)
C=O	805
C–C	347
O=O	498
O–H	464

The total energy released in the reaction between propane and oxygen is 2220 kJ / mol.

Calculate the bond energy of C–H.

Give your answer to **3** significant figures.

Bond energy of C–H = ... kJ / mol **[4]**

Candidates found this question challenging. Part of the problem was that they did not know what equation to use. Those that started by the writing the equation, and very few did, tended to then do well.

Many were able to make use of the bond energies but did not use the value 2220kJ. The value of -2220kJ was invariably ignored, thus giving 5358/8 = 670. Of those that used this figure, many put into equation as +2220. However, some candidates appreciated that whatever answer they came up with that there was 8 C-H bonds so they divided their answer by 8 and then altered it to 3 significant figures.

	AfL	These types of calculation should be practised, with candidates being shown how to set out their working. In some cases, it was impossible to tell where final figures had come from so examiners did not know if any of the steps were carried out correctly and so were unable to award any marks.

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Section B, Q15

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Section B,Q16, Table 16.1

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