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Examiners' report

GCSE

COMBINED SCIENCE B (TWENTY FIRST CENTURY SCIENCE)

OCR Level 1/Level 2 GCSE (9-1) in Combined Science B (Twenty First Century Science)

J260

For first teaching in 2016

J260/02 Summer 2025 series

Version 1

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Contents

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. A selection of candidate responses is also provided. 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 and the mark scheme can be downloaded from Teach Cambridge.

Paper 2 series overview

J260/02 is one of the four Foundation tier papers for the GCSE 9-1 examination for Combined Science. This unit links together different areas of chemistry within different contexts, some practical, some familiar and some novel. 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 that they should recognise from OCR's practical activity groups (PAGs) and suggested practicals.

There is clear evidence that candidates are able to conduct practical work to support their understanding of many key chemical concepts. In particular, Questions 4 (b) (i), 5 (b) (i) and 5 (b) (ii) were well answered by many candidates dealing with combustion of fuels, and the processes involved in the purification of water.

Where candidates could still improve further is in applying their understanding of mathematical concepts in a science context. There is evidence to suggest that candidates do not always use the transferrable skills developed in one curriculum area to support their answers in a different subject area. This was particularly evident in Question 7 (b) (iv) as explained in more detail with Exemplar 2 in the main body of the report below, and also Question 8 (c) where candidates found the use of standard form difficult to understand and so struggled to access the marks available for this question.

Candidates made good use of the time allowed and there was little evidence to suggest that they were rushing to complete the paper. The final two questions on the Foundation paper are common with the Higher tier paper. Many candidates at Foundation level not only attempted to answer these questions, but they often gained the majority of the marks available, particularly on Questions 8 (b) and 8 (d).

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• could recognise and apply their knowledge of acids and their reactions in Question 1 • could respond positively to questions about periodicity and group trends, especially Group 7 – the halogens • were able to calculate a value for the energy transfer in Question 4 (b) (ii) and attempt Question 4 (b) (iii) giving their final answer to the required number of significant figures could recall and use ideas about the development of the atom and atomic structure in Question 8 parts (a), (b) and (d), often scoring a significant proportion of the marks available.	• struggled to express their ideas clearly when discussing the benefits and risks associated with new technologies in Question 2 (b) • often found it difficult to identify the ions present in ionic species, balance equations and assign state symbols appropriately and this was evident across the paper in general could extract data from graphs presented to them, but often struggled to plot graphs (Question 6 (c) (iii)), or to interpret how the shape of the graph is changing over a period of time, Question 7 (b) (iv).

Question 1 (b) (i)

(b) Acids react with some metals to form a salt and hydrogen.

The table shows some information about the reactions between some metals and acids.

(i) Complete the table.

Metal	**Acid**	**Salt formed**
Calcium	Nitric acid	....
Iron	....	Iron sulfate

[2]

Candidates seem to find this topic quite challenging. They are often quite good at describing how to carry out the reactions of acids to prepare salts, but seem to struggle to identify which salts are prepared from which acid.

In Question 1 (b) (i) many candidates were unable to give the correct name for the calcium salt produced, or to identify the acid required to make iron sulfate.

However, higher-scoring candidates on this paper did score 1 of the 2 available marks.

Question 1 (b) (ii)

(ii) Pieces of zinc metal react with dilute sulfuric acid to form a solution of zinc sulfate and hydrogen gas.

Complete the **state symbols** in the balanced symbol equation.

$$Zn(........) + H_2SO_4(........) \rightarrow ZnSO_4(........) + H_2(........)$$

[2]

In Question 1 (b) (ii) candidates were asked to assign the correct state symbols to the species identified in a balanced equation. This produced a variety of incorrect responses ranging from atoms of oxygen, O, being inserted into the spaces provided, to numbers being randomly inserted. However, more commonly, candidates used capital letters rather than s, aq and g, and so a significant proportion of candidates did not score either of these marks.

Assessment for learning

When studying the reactions of acids, bases and salts, in addition to candidates being offered the opportunity to prepare salts from acids, it would be extremely beneficial for them to be able to practice writing equations and including the correct state symbols for as many different reactions as possible.

Question 1 (c)

(c) Acids react with alkalis to form a salt and water, for example:

HCl	+	$NaOH$	→	$NaCl$	+	H_2O
Acid		Alkali		Salt		Water

Complete the sentences to describe this type of reaction.

Put a (ring) around each correct option.

When an acid reacts with an alkali it is called **evaporation / neutralisation / precipitation**.

During the reaction, **H^+ / Na^+ / Cl^-** ions from the acid react with **H^+ / Na^+ / OH^-** ions from the alkali.

[3]

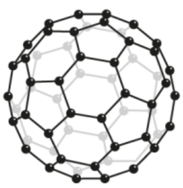
This question was attempted by almost all candidates with most recognising that the type of reaction given in the question was a neutralisation reaction and scored at least 1 mark. More successful responses saw candidates identify one of the ions involved in the reaction, usually H^+ ions from the acid and so scored 2 of the available marks.

Question 2 (a) (i)

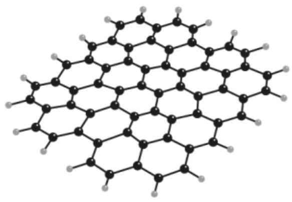
2 Nanoparticles are very small particles. They have many important uses.

(a) Fullerene and graphene are nanoparticles made from carbon.

The diagrams show their structures.



Fullerene



Graphene

(i) Complete the table to show which statements are true for fullerenes only, graphene only, both or neither.

Tick (✓) **one** box in each row.

	True for fullerene only	True for graphene only	True for both	True for neither
Each carbon atom is bonded to 5 other carbon atoms.				
The carbon atoms in each structure are covalently bonded.				
The structure is a molecule.				
The structure is a sheet of rings.				

[4]

This question was answered well by the majority of candidates with most scoring at least 2 marks, but with many scoring 3. The main error was in not identifying that graphene is a structure made up of a sheet of rings, this option was usually linked to the 'fullerene only' option.

Question 2 (b)

(b) Some scientists are worried about the use of fullerenes to carry drugs into the body.

State **one benefit** and **one risk** of using **fullerenes** in this way.

Benefit ....

....

Risk ....

....

[2]

This question was attempted by most candidates but they often gave answers that dealt with the drugs rather than the fullerene carrier molecules. When they did address the question correctly they often recognised that the benefits of using fullerenes were mainly associated with transporting the drugs quickly through the body to where they could act more effectively. When responding to the risk element of the question the most commonly seen responses were in terms of the lack of long term testing resulting in unknown side effects associated with the fullerene molecule's interactions with the body.

Question 3 (a)

3 The elements in Group **7** of the periodic table are called the halogens.

(a) Draw lines to connect each **element** with its **colour at room temperature**.

Element	**Colour at room temperature**
Chlorine	Grey
Bromine	Brown-red
Iodine	Yellow-green

[2]

Group 7 chemistry is regularly assessed in J260 but a significant proportion of candidates only scored 1 mark here. They usually correctly identified the colour of chlorine but mixed up the colours of bromine and iodine.

Assessment for learning

Centres could resolve the issue of colour identification by giving candidates the opportunity to carry out halogen/halide displacement reactions to see for themselves the colours of the aqueous solutions. This would clarify and reinforce the theory work carried out in class.

OCR support

A number of the GCSE examiners' reports this year have raised the concern that candidates' practical skills and knowledge is in decline. OCR has produced a wealth of practical resources to support teachers. You can find them on Teach Cambridge.

Question 3 (c) (i)

(c) The halogens also react with metals to form metal halides.

(i) Complete the **balanced symbol equation** for the reaction between sodium and bromine to form sodium bromide.

$$2Na + Br_2 \rightarrow ....NaBr$$ **[1]**

In Question 3 (c) (i) if candidates did not score the mark, it was usually for placing the number 4 in front of the NaBr, or placing a subscript 2 after Br. This second response is probably from simply adding together the left-hand side of the equation and omitting the + sign.

Question 3 (c) (ii)

(ii) Complete the table to show the ions present and the formulae of other metal halides.

Metal halide	Ions present	Formula
Sodium iodide	Na^+ and I^-	NaI
Magnesium chloride	.... and	$MgCl_2$
Iron(III) bromide	Fe^{3+} and Br^-	....

[3]

Candidates who find ions and ionic equations challenging often leave this type of question blank and do not engage with it.

However, this year there were very few scripts where this question was not attempted, and most candidates did attempt to provide an answer to this question.

In Question 3 (c) (ii) many candidates were able to give the correct formula of one of the ions present in magnesium chloride, however very few candidates were able to construct the correct formula for iron(III) bromide with the most common incorrect responses being $FeBr^3$ or Fe3Br.

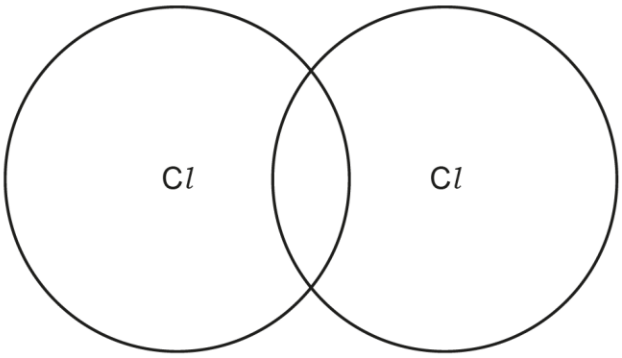
With the answers provided it is possible to see that there is an element of understanding evident but that the candidates had not spotted the pattern that was presented in the table to guide them towards the correct formulae.

Question 3 (d)

(d) Chlorine has the electron arrangement 2.8.7.

Complete the dot and cross diagram for a chlorine molecule, Cl_2.

Show the outer shell electrons only.



[2]

Most candidates attempted this question, and the higher attaining candidates scored both marks. Candidates who struggled on this paper often placed four electrons in the overlap area which resulted in them losing both marks.

Other commonly seen incorrect diagrams included ones where all of the electrons were placed in the overlap area, or four electrons were in the overlap area and four electrons were on the outer shell of each atom.

This final option again demonstrated a basic understanding of the question as they recognised that there should be eight electrons around each outer shell of the molecule but they had not counted them correctly using the electron arrangement provided in the stem of the question.

Assessment for learning

Candidates should be given the opportunity to draw a range of dot and cross diagrams for as many molecules as possible as part of any revision package that is preparing them for sitting their final examination. This should reinforce the teaching that had taken place earlier in the key stage, and cement in place their understanding of the topic.

Question 4 (a) (i)

4 Energy is transferred when reactants change into products in a chemical reaction.

(a) When solid ammonium chloride dissolves in water, energy is transferred from the surroundings to the reaction mixture.

(i) Suggest a simple experiment to show that this reaction is **endothermic**, and describe the results expected.

Experiment ....

....

Results ....

....

[2]

Questions 4 (a) (i) and (ii) were designed to assess candidates' knowledge and understanding of some key aspects of energy changes in chemistry.

Question 4 (a) (i) was asking how they could carry out an experiment to determine the type of energy change occurring.

Candidates came up with a variety of ideas, but in most cases, they struggled to score as they did not include the essential element of measuring the temperature of their solution before and after adding ammonium chloride to the water.

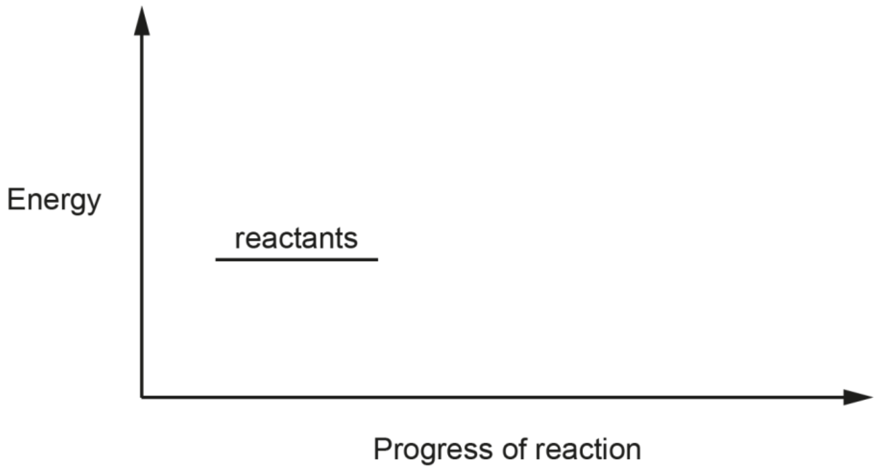
Where they did score was in recognising that the temperature would go down, often by using descriptive terms such as 'it will go cold' which was accepted as being a correct observation that the candidate might make.

Question 4 (a) (ii)

(ii) Complete the reaction profile for an endothermic reaction.

Include labels for:

- the products
- the activation energy.



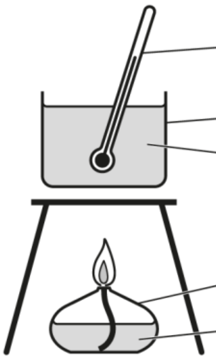
[3]

In Question 4 (a) (ii) they were asked to draw the enthalpy profile, with candidates often successful and scoring at least 2 of the available marks. The only commonly seen error was in not drawing the correct arrow for the activation energy, or not labelling this arrow correctly when they had included it as instructed in the question.

Question 4 (b) (i)

(b) A student does an experiment to find out the change in thermal energy when a fuel burns.

They use this apparatus.



They burn the fuel to heat some water.

The table shows their results.

Mass of fuel burned (g)	4.6
Temperature of water before experiment (°C)	18
Temperature of water after experiment (°C)	25
Mass of water (g)	200

(i) Describe how the mass of fuel burned is measured.

....

....

....

.... **[2]**

Questions 4 (b) (i), (ii) and (iii) looked in greater detail at a combustion reaction and assessed candidates on the results that they needed to collect and how they would process the data collected.

In Question 4 (b) (i) we wanted to determine if they knew that they needed to measure the mass of the spirit burner and fuel before and after heating up the water. This produced a variety of answers relating to weighing something. However, many candidates did not state what they would use to do this, or they talked about using a measuring cylinder and recording the amount before and after. In many cases this was linked to the can of water rather than the spirit burner. This resulted in them not gaining the first 2 marks, but if they had stated the need to work out the change (in mass) by subtracting their two numbers they could score the third mark.

Question 4 (b) (ii)

(ii) Calculate the change in the thermal energy of the water.

Use the formula:

Change in thermal energy (J) = mass of water (g) × 4.2 × temperature change (°C)

Change in thermal energy = ... J **[3]**

In Question 4 (b) (ii) candidates were required to work out the energy change using the data provided in the results table. For the majority of candidates this was done successfully and they scored both marks here. The only commonly seen error was in using either 25 or 18 in the calculation which would result in the loss of 1 mark only.

Question 4 (b) (iii)

(iii) Calculate the change in thermal energy of the water if only 1 g of fuel was burned.

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

Give your answer to **2** significant figures.

Change in thermal energy = ... J **[3]**

The final calculation in Question 4 (b) (iii) was more challenging for most candidates. It required them to recognise that they needed to divide their answer from the previous calculation by 4.6, the mass of fuel burnt from the results table, and then to give their final answer to two significant figures.

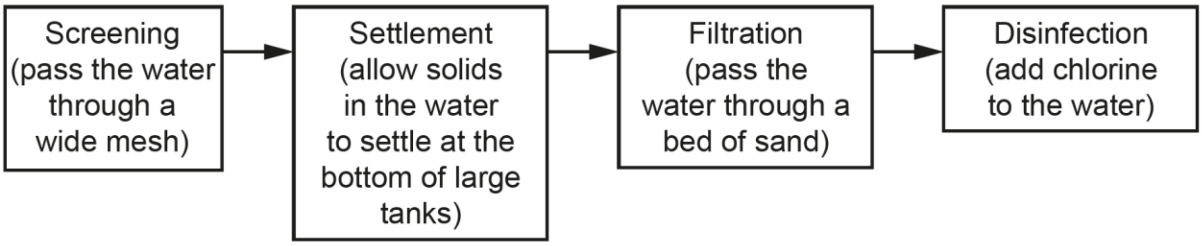
If they identified the mass of fuel used as 4.6g, they often simply replaced the mass of water in the calculation by 4.6 and then evaluated their 'new' calculation. If they did this correctly, then by use of ECF (error carried forward), they could score the second marking point. If they converted this value to the required number of significant figures, they could also score the third mark.

Often this last mark was not scored as candidates seemed to confuse numbers of significant figures with numbers of decimal places and converted their final calculated value to 2dp, which did not score.

Question 5 (a)*

5 Drinking water in the UK can be obtained from rivers. Rivers are a type of surface water.

(a)* The diagram shows some stages of the treatment to make surface water more suitable for drinking.



Surface water contains impurities including:

- large objects such as branches or leaves
- other insoluble items such as grit, sand and soil
- harmful microorganisms
- dissolved minerals
- other pollutants.

Explain which impurities are removed at each stage of the process shown **and** why the treated water is now more suitable for drinking but is still **not** considered scientifically pure.

[6]

Exemplar 1

During the screening stage large objects such as branches or leaves are removed as they cannot pass through the mesh. Then, other insolunable items such as grit, sand, or soil are settled at the bottom of large tanks. Filtration then removes dissolved minerals and harmful microorganisms, filtering out the impurities. Finally, the water is chlorinated to remove and kill any final pollutants. The water is now potable however it is not scientifically pure as there are toxic chemicals such as chlorine in the water. **[6]**

This response was typical of the vast majority of responses produced for this question. The most pleasing aspect of this question was that the majority of candidates tried to explain the stages involved in water purification.

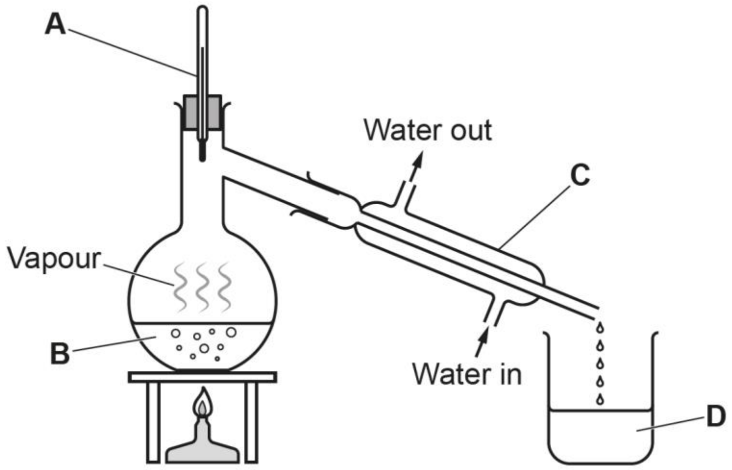
In this exemplar, the candidate has tried to link each of the impurities given with the stage in the process where they are removed. This was a common approach adopted by most candidates. They correctly identify where large objects are removed and where some of the smaller objects are removed in the settlement tank. After this, they try to remove the dissolved minerals and microorganisms by filtering which is incorrect and so the response is best matched to Level 2. The overall quality of the communication shows a logical approach, their ideas are clearly structured, address all areas of the task set and so was given a mark of 4.

In order to progress to Level 3 the candidate would have needed to explain how each stage works to remove the various items in the water, e.g. at stage 1 the large objects cannot pass through the mesh. Finally, the question asks candidates to explain why the water is suitable to drink but is not scientifically pure. This is where it might be expected that the candidate would recognise that the dissolved minerals could not be removed by any of the stages identified, and that at stage 4 the addition of chlorine would have added an additional chemical to the water and so it cannot be described as being pure even though it would be safe to drink.

Question 5 (b) (i)

(b) Some countries get their drinking water from seawater. Seawater contains dissolved salts such as sodium chloride.

A student plans to use distillation to separate the salt from the water, using this apparatus:



(i) Complete the table by identifying the labels, **A**, **B**, **C**, and **D** on the diagram.

Use words from the list.

Burette	**Burner**	**Condenser**	**Funnel**
Pipette	**Seawater**	**Thermometer**	**Water**

	Label
A	
B	
C	
D	

[4]

Questions 5 (b) (i) and (b) (ii) were extremely well answered by most candidates and it was not unusual to see candidates scoring 6 or more marks across both parts.

In Question 5 (b) (i) they clearly had recognised the distillation process and could identify both the apparatus used and what is happening to the water in the experiment.

Question 5 (b) (ii)

(ii) Complete the sentences to explain how distillation separates the salt from the water.

Put a ring around each correct option.

The separation occurs because the salt and water have different **boiling / freezing / melting** points. The **salt / solution / water** evaporates and the vapour passes through the condenser where it is **cooled / heated / stirred**. The **salt / solution / water** condenses and is collected in the beaker.

[4]

In part (b) (ii) candidates were able to correctly select the required words to describe the changes occurring, something that lower attaining candidates might have struggled to do had they been presented with this question as an open response activity.

Question 6 (a)

6 The compounds found in crude oil are mostly in the alkane homologous series.

(a) State **one** way in which modern life is dependent upon hydrocarbons.

....

.... **[1]**

Question 6 addressed the organic chemistry topic in the specification.

These first two questions tried to elicit candidates' basic ideas about this topic.

In Question 6 (a) there was a variety of correct responses that demonstrated that candidates had an awareness of how this area impacts their everyday lives from transportation and use of fuels to plastics and manufacturing.

Question 6 (b)

(b) The alkanes are all hydrocarbons with a general formula C_nH_{2n+2}.

What is the molecular formula of the alkane with **8** carbon atoms?

.... **[2]**

In part (b) we wanted to see if candidates could use a general formula to derive the molecular formula for a given hydrocarbon.

Some common responses saw a correct answer given to part (a) and a correct value of C_8 as part of their attempt to derive the molecular formula. The most seen incorrect formula included the final part of the molecular formula given as $H_{2(8)+2}$ which may be mathematically correct but is not the recognised chemical formula.

Higher-scoring candidates on this paper scored all 3 marks across these two questions.

Question 6 (c) (i)

(c) The table shows some information about some alkanes.

Number of carbon atoms	Melting point (°C)	Boiling point (°C)
5	–130	36
6	–95	69
7	–91	98
9	–54	151
10	–30	174

(i) Describe the trend in melting points shown in the table.

....

.... **[1]**

In Question 6 (c) (i) and 6 (c) (ii), it was important that candidates could recognise the nature of negative numbers when associated with physical properties of substances. This has consistently been an area where candidates have struggled.

In part (c) (i) typical responses stated that as the number of carbon atoms increased, the melting point decreased, which is incorrect. Other incorrect responses included linking the melting and boiling points with no mention of the number of carbon atoms, and generalised statements such as 'going down the table they increase'.

Question 6 (c) (ii)

(ii) The alkane with 6 carbons has a melting point of –95 °C and a boiling point of 69 °C.

Predict the state of this alkane at 20 °C.

.... **[1]**

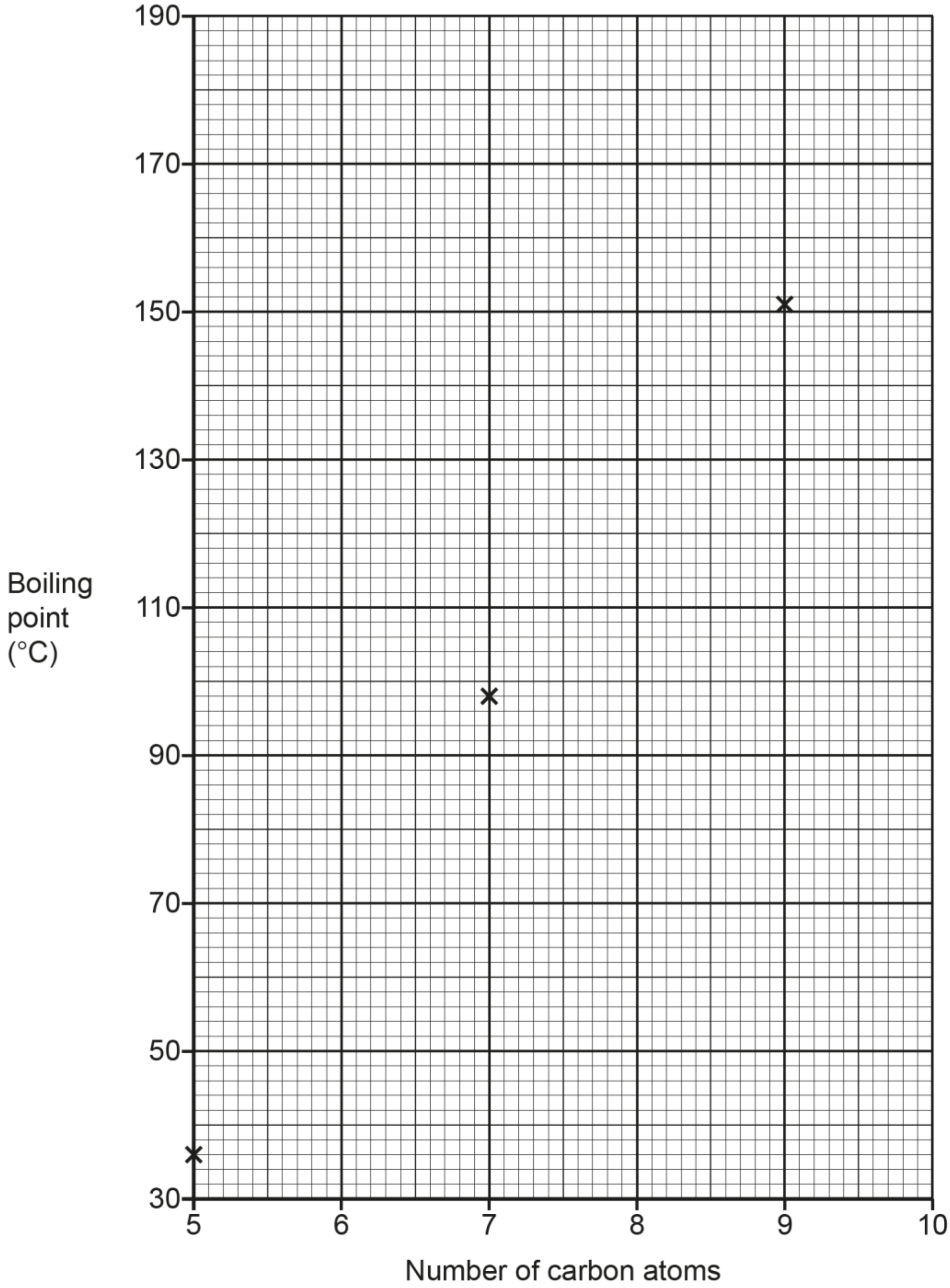
Where candidates struggled to interpret the trend in data in part (c) (i) they then also struggled to identify the physical state of the alkane in (c) (ii) using the data provided.

The combination of negative and positive numbers seemed to confuse some candidates, and it was not unusual to see answers such as 'it has melted', 'it is not yet boiling', etc. that have some validity to them but were not accepted as the states of matter are taught consistently across KS3 and KS4. They should be familiar terms for candidates to identify and provide an appropriate answer.

Question 6 (c) (iii), (iv) and (v)

(iii) Plot the results from the table on the graph.

Three points have already been plotted.



[2]

(iv) Draw a **straight** line of best fit. **[1]**

(v) Use the graph to estimate the boiling point of the alkane with 8 carbon atoms.

Boiling point = ... °C **[1]**

Questions 6 (c) (iii), (iv) and (v) assessed candidates' maths skill of graph drawing and interpretation.

In part (c) (iii) candidates were asked to plot the two missing values from the table of data, and then in part (c) (iv) to draw a straight line of best fit.

If points were incorrectly plotted, then examiners were encouraged to use their judgement about the line of best fit and to award the mark provided that the line touched both sides of the grid.

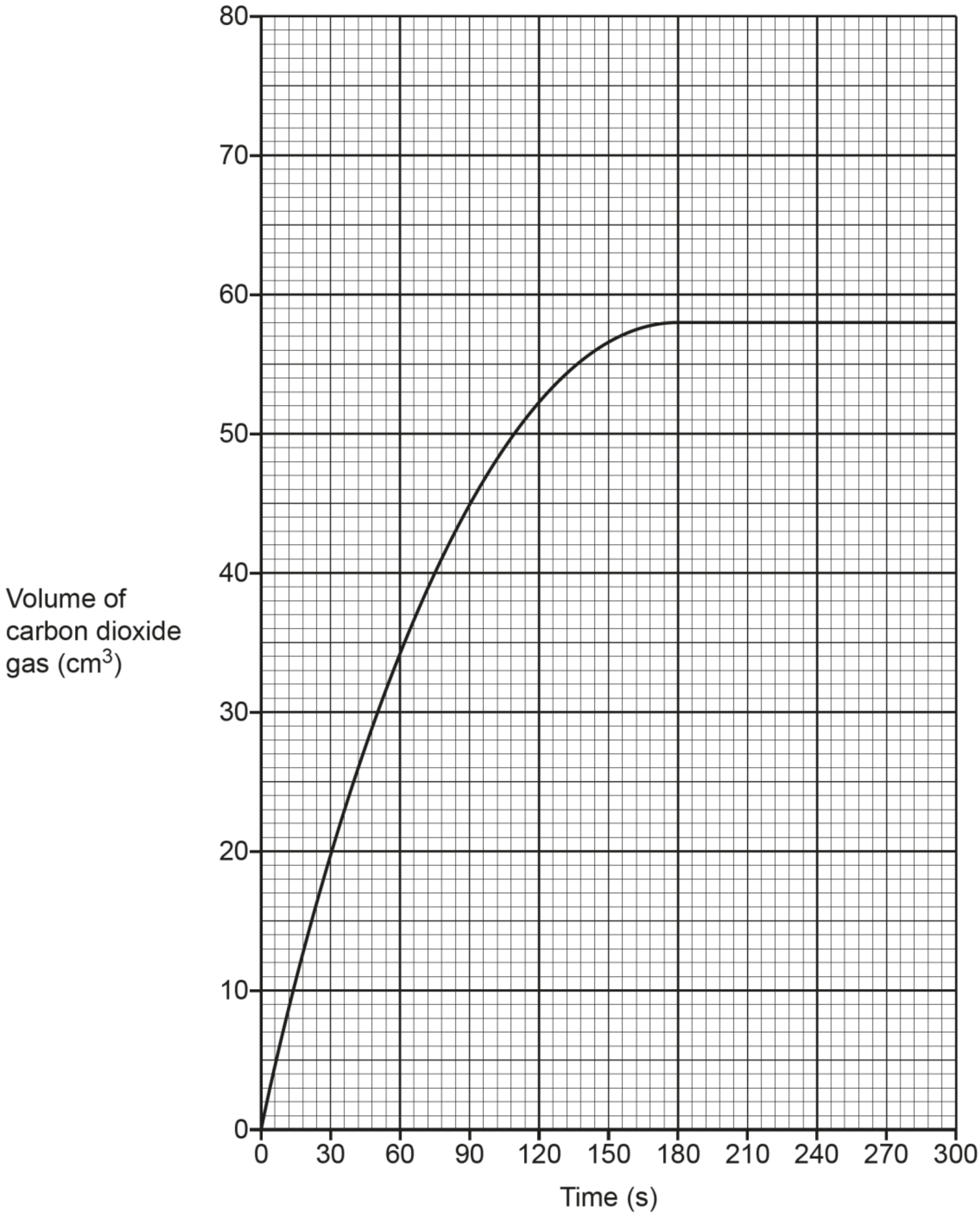
Finally in part (c) (v) they were asked to predict the boiling point of the alkane with 8 carbon atoms. If their line was drawn accurately, then the value should have been approximately 124°C, however examiners were encouraged to use ECF and look for a correct value based upon the intercept of the candidate's line of best fit.

On the whole, these three questions were answered well by candidates and it was not surprising to see them scoring the majority of the marks available.

Question 7 (b) (i)

(b) The student repeats the experiment under different conditions.

The student plots a graph with their results.



(i) What is the time taken for the reaction to finish?

Time taken = ... s **[1]**

Question 7 (b) (i), (b) (ii) and (b) (iii) assessed some basic maths skills. In this case candidates were asked to interpret a volume/time graph as part of a question dealing with rates of reaction. This is a topic area that candidates often perform well on.

In Question 7 (b) (i) candidates were asked to identify when the reaction was completed, this will be the point where the curve flattens at 180s, examiners did have the discretion to allow any time between 174s and 180s to take into account the thickness of the curve on the printed graph.

Question 7 (b) (ii)

(ii) What is the volume of carbon dioxide collected when the reaction has finished?

Volume of carbon dioxide collected = ... cm^3 **[1]**

In Question 7 (b) (ii), candidates were using the graph to identify the total volume of gas produced when the reaction was complete. This time they needed to look at the plateau and read off the volume from the *y*-axis. As the graph flattens exactly onto a grid line, the only acceptable answer here was $58cm^3$.

Question 7 (b) (iii)

(iii) Calculate the average rate of reaction from the start to the end of the reaction.

Use the equation: $\text{average rate of reaction } (cm^3/s) = \dfrac{\text{volume of carbon dioxide collected } (cm^3)}{\text{time taken (s)}}$

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

Average rate of reaction = ... cm^3/s **[3]**

Finally in Question 7 (b) (iii) candidates needed to use their values from parts (i) and (ii) to calculate the average rate of reaction using the expression provided.

Most candidates were able to calculate a value for the rate, and examiners applied ECF so that any incorrect values in part (b) (i) or (b) (ii) could be used without any further loss of marks.

So, on these three questions it was not unusual to see candidates scoring 4 or more marks over the three parts.

Question 7 (b) (iv)

(iv) Describe the changes in the gradient of the graph and the rate of reaction shown in the graph.

Gradient ....

....

....

....

Rate ....

....

....

....

[4]

Exemplar 2

Gradient the gradient increases till 180s when the volume of gas no longer increases and becomes constant and no more reaction happens.

Rate the rate of reaction increases till a certain point when the reaction stops and stays at a constant because it cant increase anymore

[4]

This final part of Question 7 was not so well answered by candidates. They often gave contradictory responses that either simply addressed how the speed of the reaction was changing over time, or they stated that the reaction was over by 180 seconds for both sections.

In the exemplar chosen, for the gradient the candidate has scored the second mark but not the first. They have not recognised that the gradient is becoming less steep as time progresses but do identify that the gradient becomes constant as the graph flattens.

For the rate of reaction, they do not recognise that the speed decreases as time progresses, but they have scored second mark for stating that the rate becomes constant.

One commonly seen error was where candidates stated that the gradient stopped, rather than the reaction stopped.

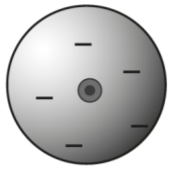
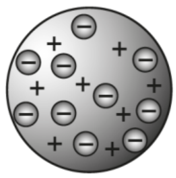
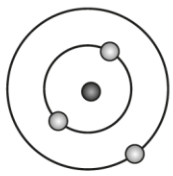
Candidates seemed to struggle to identify what the question was asking for and this was reflected in the answers seen.

Question 8 (a)

8 In the 1800s, Dalton did experiments to help produce a model for the atom.

(a) Later discoveries led to scientists suggesting new models for the atom.

Draw lines to connect each **discovery** with the **model** it led to.

Discovery	**Model**
Electrons are discovered.	
Electrons are in shells.	
Nucleus is discovered.	

[2]

The final two questions, Question 8 and Question 9, were the overlap questions with the Higher tier.

Many candidates attempted most parts of these questions, with some success.

In Question 8 (a) candidates usually scored 1 mark as they correctly linked the discovery of electrons in shells to the correct diagram on the right-hand side of the page.

Question 8 (b)

(b) The modern model of the atom consists of electrons, neutrons and protons.

Which statements about the modern model of the atom are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Neutrons have a charge of 0.		
Protons and electrons are in the nucleus.		
Protons and electrons have a relative charge of –1.		
Protons and neutrons have a relative mass of 1.		

[3]

This question was not only attempted by most candidates, they also scored most of the marks available.

Most candidates recognised that statement 2 was false and statement 4 was true, to score 1 mark, and many also knew that neutrons have a charge of 0 and so scored 2 of the 3 marks available for this question.

Question 8 (c)

(c) The diameter of an atom is 1×10^{-10} m and the diameter of a nucleus is 1.7×10^{-15} m.

Estimate how many times bigger the atom is compared to the nucleus.

Number of times bigger = ... **[2]**

This part of Question 8 was often left blank; numbers presented in standard form seemed to confuse the candidates and so they did not attempt this question.

When candidates did make an attempt to answer the question they often subtracted the smaller value from the larger value or they wrote a number string where an attempt to cancel trailing zeros was made to arrive at their estimated value. This was the most difficult question for candidates on this paper to access the marks.

Question 8 (d)

(d) The atomic number and mass number can be used to find the number of protons, neutrons and electrons in an atom.

The table shows information about an argon atom and a potassium atom.

Complete the table.

	Argon atom	**Potassium atom**
Atomic number	18	....
Mass number	40	....
Number of electrons	....	19
Number of neutrons	....	20
Number of protons	....	19

[4]

The final part of the question was a good question for this paper as it dealt with an area of study that they could engage with successfully. Many candidates scored all 4 marks and very few did not score any marks when they had attempted this question. The only commonly seen error on this question was candidates quoting the relative atomic mass value for potassium (39.1), taken from the periodic table, rather than its mass number that they should have been able to work out from the data provided.

Question 9 (a)

9 Zinc is extracted from its ore by separating the zinc compounds from the waste rock and then converting the zinc compounds into zinc.

(a) A company wants to extract 5.5 kg of zinc from an ore which contains 8.5% zinc.

Calculate the mass of ore needed.

Use the equation: percentage of zinc in ore = $\frac{\text{mass of zinc} \times 100}{\text{mass of ore}}$

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

Mass of ore = ... kg **[4]**

Exemplar 3

(a) A company wants to extract 5.5 kg of zinc from an ore which contains 8.5% zinc.

Calculate the mass of ore needed.

Use the equation: percentage of zinc in ore = $\frac{\text{mass of zinc} \times 100}{\text{mass of ore}}$

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

mass of ore = $\frac{\text{mass of zinc} \times 100}{\text{percentage of zinc in ore}}$

8.5+100=108.5

1.085

$\frac{5.5 \times 100}{1.085}$

Mass of ore = ...507...... kg **[4]**

The final exemplar illustrates a good response showing how more successful candidates on this paper were often scoring 3 of the 4 available marks. Even candidates who had struggled with the calculation on the previous question attempted this, and many were rewarded by scoring one mark if they displayed their working and quoted their final response to 3 significant figures.

In some instances this final mark was the only mark that the candidate scored, but it was rewarding them for attempting to answer the question, rather than leaving it blank which would have resulted in no marks being scored.

Question 9 (b)

(b) The zinc compounds are heated strongly to produce zinc oxide.
The zinc oxide is then heated with carbon to produce zinc and carbon monoxide.

$ZnO + C \rightarrow Zn + CO$

Explain which substance is oxidised and which is reduced in this reaction.

Oxidised ....

....

Reduced ....

....

[2]

In many instances candidates simply wrote down the name of the species that they believed had been oxidised/reduced but did not give any explanation which usually meant that they did not score any marks here.

Common incorrect responses included stating that carbon monoxide was oxidised because it had gained oxygen, or that zinc was reduced because it had lost oxygen. In both instances there is some merit to their answer as they recognised the products of the two processes rather than the reactant.

Question 9 (c)

(c) Many metals cannot be extracted using carbon.

Explain why zinc can be extracted using carbon but aluminium **cannot**.

Zinc ....

....

Aluminium ....

....

[2]

The final question of this paper was attempted by a large number of candidates. This is encouraging as it demonstrated that they had made good use of the time available and were able to engage with the entire paper including material that was common to the Higher tier.

Many candidates gave answers to the question that related to the physical properties of the metals in comparison to carbon, e.g. zinc is stronger so cannot be extracted, aluminium has a higher boiling point than carbon so cannot be extracted, and these were perhaps indicative of candidates who had been encouraged to write something down rather than leaving the space blank.

However, a good number of the more successful candidates on this paper gave responses that related to the reactivity series and often were doing so successfully by recognising that carbon is more reactive than zinc so can reduce zinc oxide but is less reactive than aluminium and so cannot reduce aluminium oxide. In doing so these candidates scored the final 2 marks available on the paper.

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