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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/02 Summer 2024 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 OCR.

Paper 2 series overview

J260/02 is one of four papers that comprise GCSE(9-1) Combined Science B (Foundation Tier).

The paper addresses all areas of the chemistry content of this course, including many practical areas that students should have had the opportunity to explore as part of their study of chemistry. To do well on this paper, candidates needed to be comfortable applying their knowledge and understanding within different contexts, some practical, some familiar and some novel.

There is clear evidence that candidates are able to carry out practical work to support their understanding of many key chemical concepts. In particular Questions 4 and 5 (d) were well answered by many candidates dealing with salt preparations and chromatography. Where candidates could still improve further is in applying their understanding of mathematical concepts in a science context. Questions 9 (a) (ii) and 9 (c) were examples of where candidates struggled with some aspects of maths.

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 tier not only attempted to answer these questions, but they often gained the majority of the marks available, particularly on Question 10.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• were able to name an example of a greenhouse gas and suggest an appropriate method to reduce carbon dioxide levels in the atmosphere • gained most of the marks available for demonstrating their knowledge about chromatography • were able to analyse a practical situation and state which measurements were required and choose the most appropriate measuring instrument for the activity • could successfully plot the points for the graph in **Question 10 (b)** and draw a suitable line of best fit that they could then use to determine the temperature change when a non-integer mass of solid was used.	• struggled to describe the electron configurations of ions and to draw the dot and cross diagrams associated with cations and anions • found it difficult to express their ideas about kinetic theory in the context of a solid being warmed in **Question 5 (a) (ii)** • struggled with the concept of empirical formulae as evidence in **Question 7 (d)** • found **Question 9** to be a challenge. In particular they struggled to arrange particles in order of size when given data in standard form. They also often did not engage with **Question 9 (c)** where they were required to employ maths knowledge and understanding about volumes and surface area.

Question 1 (a) (i) and (ii)

1

(a) **Table 1.1** shows information about some of the elements in the Periodic Table.

Table 1.1

Element	Atomic Number	Group Number	Period	Electron Configuration
....	8	16(6)	2	2.6
Sodium	11	....	....	2.8.1
Chlorine	....	17(7)	3	2.8.7
Calcium	20	2	4	....

(i) Complete **Table 1.1**.

Use the Data Sheet. **[5]**

(ii) When atoms lose or gain electrons, they form charged particles called ions.

State the electron configuration of Na^+ **ions** and Cl^- **ions**.

Na^+ ....

Cl^- ....

[2]

These provided a good starting point for many candidates. Most candidates scored at least four of the available marks in part (i) with the only commonly seen error being in writing the electron configuration for calcium. This was also the case in part (ii). Most candidates who attempted part (ii) gave the configurations for the elements rather than the ions. The most commonly seen incorrect responses saw the sodium ion given as 2.8.2 with one electron added, and for the chloride ion 2.8.6.

Misconception

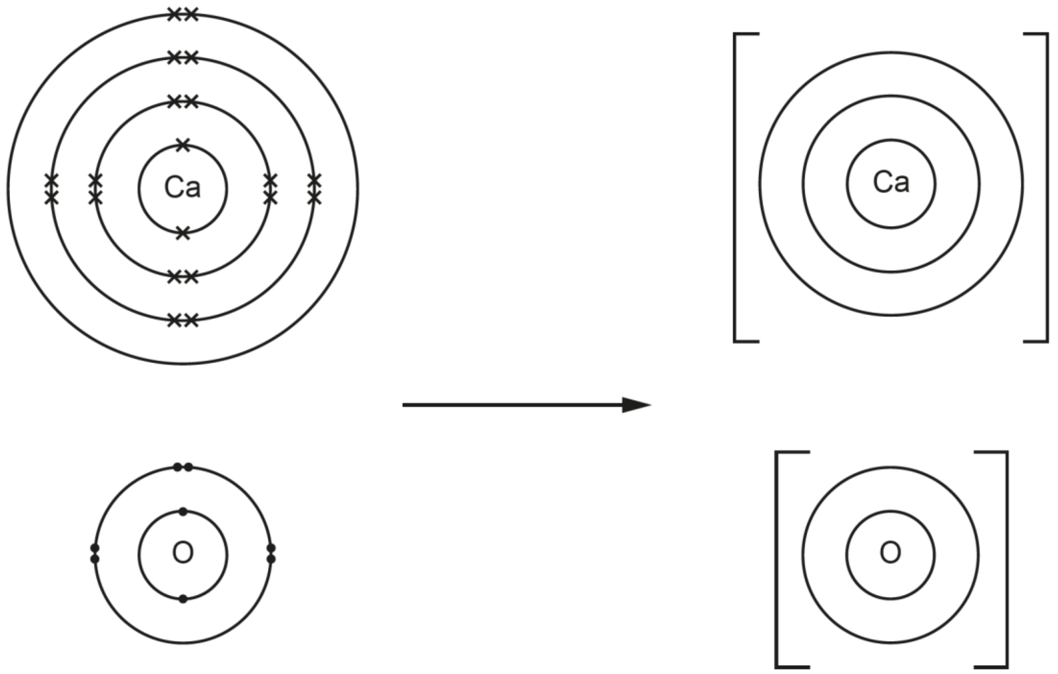
It would appear that when dealing with ions, many candidates believe that a positive ion is formed by ADDING electrons, and that a negative ion is formed by SUBTRACTING electrons. Candidates would benefit from access to lots of practice on drawing and writing electron configurations as part of their revision before the examination season.

Question 1 (b)

(b) Ionic compounds form when electrons are transferred from one atom to another.

A dot and cross diagram is a model used to show the formation of an ionic compound.

Complete the diagram to show the **arrangement of electrons** and the **charge of the ions** in calcium oxide.



[2]

Unsurprisingly, given that candidates struggled with electron configurations in (a) (i) and (a) (ii), this question also posed problems to candidates. There was clear evidence that the link between the charges and the electron arrangements was not fully understood. Many candidates completed the electron arrangement for the calcium ion correctly, but then labelled it with a 2- charge. Similarly, if a candidate drew the oxide ion with a complete outer shell this was often labelled with a 2+ charge. In this situation provided that the electron arrangements were correct for both ions then a mark of one was given.

Question 1 (c)

(c) **Table 1.2** gives information about some other ionic compounds.

Table 1.2

Compound	Ions Present	Formula	Relative Formula Mass
....	Na^+ and Cl^-	NaCl	58.5
Magnesium chloride	....	$MgCl_2$	....
....	Mg^{2+} and O^{2-}	....	40.3

Complete **Table 1.2**.

Use these relative atomic masses: Mg = 24.3, Cl = 35.5.

[5]

In this question, most candidates scored at least two marks, for identifying sodium chloride and magnesium oxide as the relevant compounds. More successful candidates often scored 3 or 4 marks by using the information presented about the ions present in compounds 1 and 3 to identify the ions in magnesium chloride as Mg^{2+} and Cl^-, and gave the correct formula, MgO, for magnesium oxide. Very few candidates correctly calculated the formula mass of magnesium chloride as 95.3, with the most commonly seen incorrect value being 59.8 by simply adding together the values for the relative atomic masses given below table 1.2

Question 2 (a) (i)

2 This question is about climate change.

(a)
(i) Complete the sentence to describe how the presence of carbon dioxide in the atmosphere causes an increase in global temperatures.

Put a (ring) around each correct option.

Global warming occurs when **infrared / ultra violet / visible** radiation coming from

the Earth / the Sun / space is absorbed by carbon dioxide which prevents heat leaving

the atmosphere.

[2]

This question provided a variety of incorrect responses. Many candidates recognised that the type of radiation responsible for the increase in global temperatures is infrared radiation, however they often stated that the source of this radiation was the sun and so did not score the second available mark for this question.

Question 2 (a) (ii)

(ii) Name **one other** greenhouse gas.

.... **[1]**

This question was surprisingly poorly answered. Many candidates were able to name a pollutant gas present in the atmosphere but they were often gases associated with other issues such as acid rain. However, the most commonly seen incorrect response was to identify Carbon Monoxide as an alternative greenhouse gas.

Question 2 (b)

(b) One method to reduce the amount of carbon dioxide in the atmosphere is called carbon capture. Carbon dioxide from power stations is collected and buried deep underground.

State **one** other method to reduce the amount of carbon dioxide in the atmosphere.

....

.... **[1]**

There was a huge variety of responses to this question. Most candidates realised that the best method of reducing carbon dioxide levels in the atmosphere would be to plant more trees as this provided a natural method of removing CO_2 via photosynthesis. However, other acceptable common responses included using various forms of renewable energy or changing to electric vehicles from those using fossil fuels.

Question 3 (a) (i)

3 A student investigates the reaction between zinc carbonate and dilute acids.

(a)
(i) Complete the balanced symbol equation for the reaction between solid zinc carbonate and dilute acid.

Include state symbols. **[4]**

$$ZnCO_3(s) + \text{..........}HCl(\text{..........}) \rightarrow ZnCl_2(\text{..........}) + CO_2(\text{..........}) + H_2O(\text{..........})$$

This question proved to be a good discriminator between candidates. Higher attaining candidates often scored two or three of the available marks, and only missed out on scoring all four as they used the state symbol (s) for the zinc chloride produced in the reaction. Less successful candidates either omitted this question or scored one or two marks for identifying the correct state symbols for water and/or carbon dioxide.

Assessment for learning

Many candidates still struggle to assign the correct state symbol to species in chemical equations. There is an opportunity here, when studying the reactions of acids, for teachers to build in opportunities to practise writing equations that include assigning state symbols to the appropriate species.

Question 3 (a) (ii)

(ii) Name the acid used and the salt formed in this reaction.

Acid ....

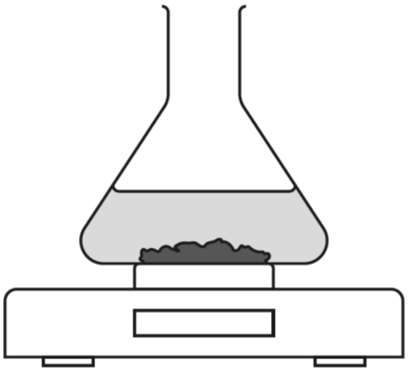
Salt ....

[2]

There was no obvious pattern to candidates' responses on this question. The most common incorrect responses saw the acid named as 'dilute acid' which is the description used in the stem of the question, or the salt named as 'table salt', or zinc carbonate which is the reactant rather than a product. However, a significant number of candidates did score one mark as they recognised that HCl was the correct formula for hydrochloric acid, and we did allow this to be identified as hydrogen chloride.

Question 3 (b) (i)

(b) The student adds zinc carbonate to dilute acid in a conical flask. The flask is on a mass balance.



(i) Which statement explains what will happen to the reading on the mass balance as the reaction goes on?

Tick (✓) **one** box.

The mass will go down because carbon dioxide gas leaves the flask. ☐

The mass will go down because the water dilutes the acid. ☐

The mass will go up because carbon dioxide is denser than air. ☐

The mass will go up because some of the reactants are still present. ☐

[1]

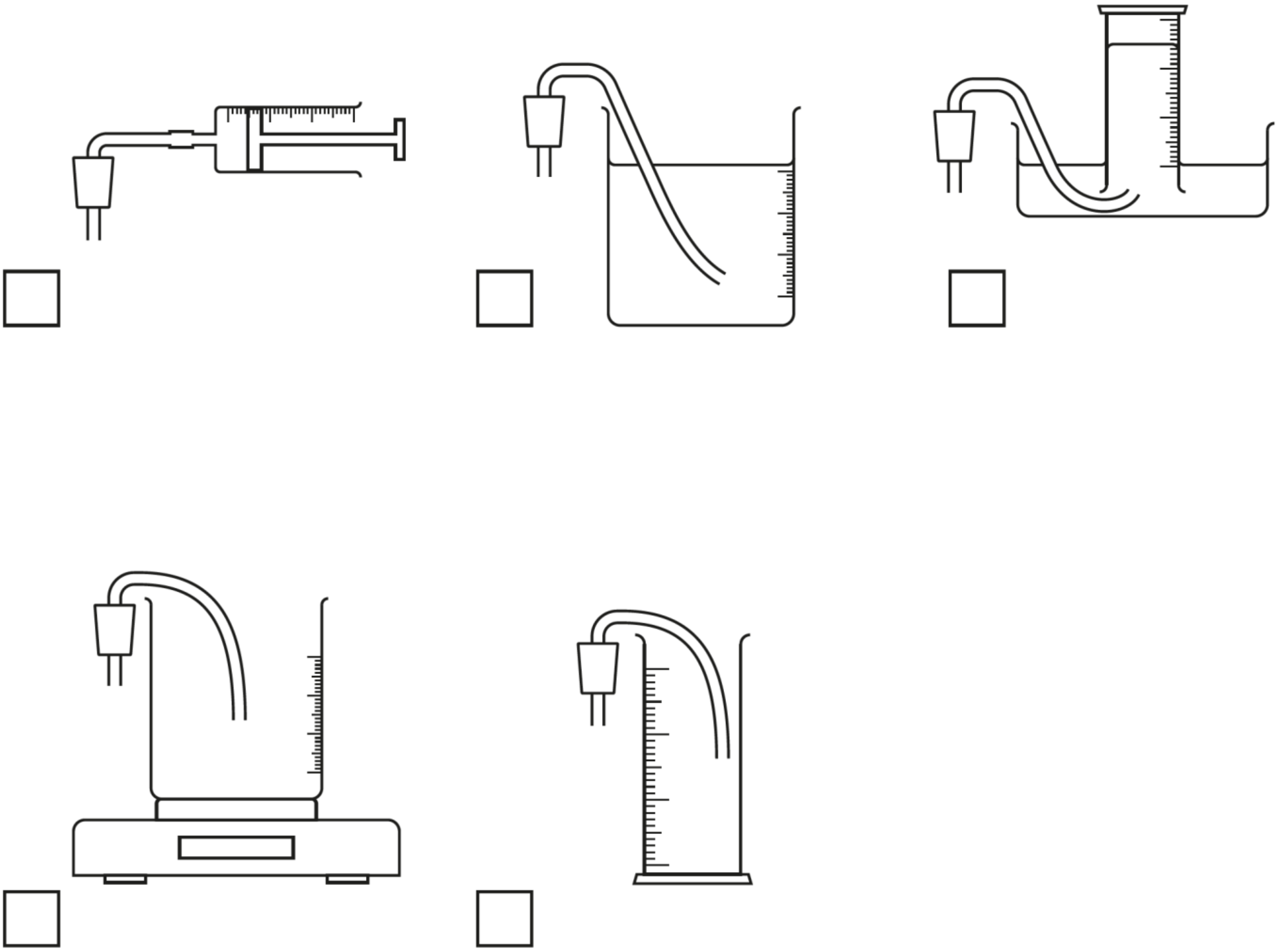
This is a method of following the course of a reaction where a gas is produced that candidates will have probably seen demonstrated in class. While this is an acceptable method to use as centres will not have access to sufficient balances to allow for a class practical activity, it can create an issue for students as quite often the emphasis is placed on asking students to record what they can see happening and they do not always note that there is a mass change in the reaction. Candidates answered this based on what they could see in the diagram and so gave option 4 as their incorrect response.

Question 3 (b) (ii)

(ii) The student decides to measure the volume of carbon dioxide gas.

Which **two** pieces of apparatus should be used?

Tick (✓) **two** boxes.

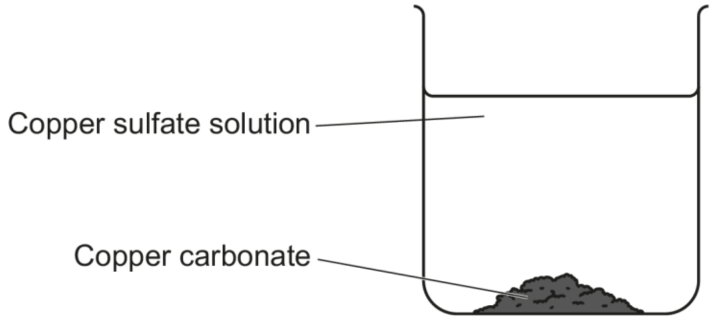


[2]

In this question, candidates were asked to identify the most suitable method of measuring the volume of gas produced. Many candidates did correctly identify the gas syringe for one mark, and a good proportion of candidates also recognised that the volume could be measured by collecting the gas over water in an upturned measuring cylinder for a second mark. Where candidates were less successful overall this was reflected here with the gas being collected in the open vessels where it could not be measured.

Question 4 (a) and (b)

4 A student makes some blue crystals of copper sulfate. They add copper carbonate to sulfuric acid in a beaker until there is unreacted solid at the bottom of the container.



(a) Why does the student add copper carbonate until there is unreacted solid?

Tick (✓) **one** box.

So that all the acid is used up. ☐

So that all the carbonate is used up. ☐

So that no product is left in the solution. ☐

So the solid is the main product. ☐

[1]

(b) How can the student speed up the reaction?

Tick (✓) **two** boxes.

Add water to the beaker. ☐

Heat the solution in the beaker. ☐

Use a bigger volume of acid. ☐

Use a more concentrated acid. ☐

Use bigger pieces of copper carbonate. ☐

[2]

This pair of questions were intended to address an activity that students should have had the opportunity to study as one of their required practical activities within the course.

In 4(a) the only option not chosen by students was option 2 – so that all of the carbonate is used up – as the diagram clearly shows unreacted copper carbonate at the bottom of the conical flask. However while many candidates did correctly identify that option 1 was the correct explanation, a significant number of candidates did choose option 4, again possibly as a result of the diagram showing a solid present in the bottom of the flask.

In 4(b) many candidates correctly identified 'Heat the solution in the beaker' as a correct method for increasing the rate of reaction. However, there were still some candidates who ticked this as their only choice – even though in bold it clearly states the need to 'tick two boxes'. Where a second box was chosen the more commonly seen incorrect response were either 'Use bigger pieces of copper carbonate', or 'Use a bigger volume of acid'

Question 4 (c)

(c) Which stages of the method to produce blue crystals of copper sulfate are **true** and which are **false**?

Tick (✓) **one** box in each row.

Stage	True	False
Filter and collect solid residue.		
Filter and collect solution.		
Evaporate the solution to dryness using a Bunsen burner.		
Leave solution to cool slowly and collect crystals.		

[3]

This style of question confused some lower attaining candidates. Many responses reversed options 1 and 2 which limited the mark they could score. It was quite common to see that the only mark scored by candidates of all levels of practical experience was to correctly identify that 'Leave the solution to cool slowly and collect crystals' was a true statement for one mark.

Assessment for learning

Develop strategies, e.g. card sort exercises, to help candidates to practise putting the steps in a practical procedure into the correct sequence, and/or, identify steps that are correct via the use of true/false statements.

Question 5 (a) (ii)

(ii) Describe what happens to the movement and arrangement of the particles when a solid is heated until it melts.

Movement ....

....

Arrangement ....

....
[2]

This question proved to be more challenging to candidates. The underlying message from candidates' responses regarding the movement of particles in a solid conveyed the impression that many believed that they are not moving, rather than vibrating about a fixed position. So incorrect responses often began with 'The particles begin to vibrate/move' which was not sufficient to score a mark as they need to include the idea that the vibration/movement increases, e.g. vibrates faster/moves faster, etc.

With the second aspect, there were more correct ideas conveyed. Typically, responses such as 'the particles spread out' or 'they are no longer touching or in a fixed position' were accepted as valid descriptions for how the arrangement of particles in the solid change as thermal energy is supplied. They only lost this mark if they made the mistake of giving a statement where it was clear that they thought that the solid had melted and turned into a liquid.

Question 5 (b)

(b) Mercury has a melting point of –39 °C and a boiling point of 357 °C.

What is the state of mercury at 20 °C?

.... **[1]**

This type of question often appears on this level of question paper. Despite much work being carried out in centres over the interrogation of data, candidates still struggle with the idea of negative values. This was clearly evident here where the most common response saw the state of mercury identified as a solid, when the data presented shows that it should be a liquid. The concept of melting points below 0°C is one candidates struggle to come to terms with and this is often identified in questions of this nature that assess their ability to apply their knowledge and understanding about states of matter and kinetic theory.

Question 5 (c) (ii)

(ii) How does the melting point of a substance show if it is pure?

....

.... **[1]**

Candidates found this question to be challenging and often discussed the magnitude of the melting point in relation to the purity of the substance, e.g. if it has a high melting point then it is pure. There were also some responses that suggested that candidates may have omitted this question initially, and only returned to it after answering the question on chromatography, as they started to discuss the purity in terms of colour changes.

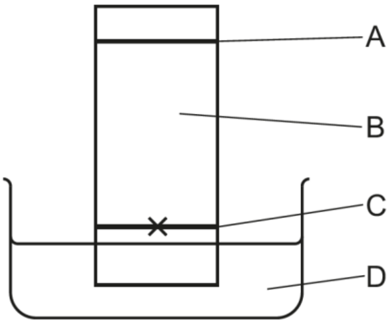
Practical Opportunity

Centres should give thought to planning a practical activity that allows students the opportunity to measure the melting point of a pure solid, such as octadecanoic (stearic) acid, and a mixture of this substance with an impurity to observe the effect of the impurity on the melting temperature. The pure solid should have a sharp melting point and the presence of the impurity should demonstrate that the melting point changes and occurs over a range of temperatures.

Question 5 (d) (i) and (ii)

(d) Chromatography can also be used to test for purity.

The diagram shows the apparatus used.



(i) Draw lines to connect each **letter** with its correct **label**.

Letter	**Label**
A	Chromatography Paper
B	Solvent
C	Solvent Front
D	Starting Line

[3]

(ii) How would the results of this experiment show that a substance was pure?

....

.... **[1]**

This was a well answered question and many candidates scored all three marks in part (i). The only common error saw candidates mix up the naming of choices A and C. In addition to this they were also scoring the mark in (ii) by clearly indicating that a pure substance would have a single-coloured spot/dot, etc, or that an impure substance would give rise to many different coloured spots or a multicoloured streak. Either response was acceptable, as this demonstrated that candidates had clearly had the opportunity to carry out this practical activity and to be able to relate the outcomes to the purity of the substance being analysed.

Question 5 (d) (iii)

(iii) What step is needed if the substance being tested is colourless?

Tick (✓) **one** box.

Use a locating agent at the end. ☐

Use a second piece of paper. ☐

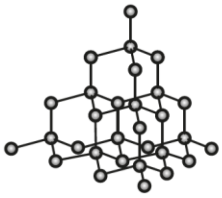
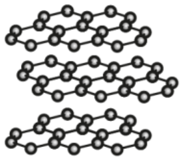
Use an extra solvent. ☐

[1]

This question seemed to puzzle candidates as there was no discernible pattern to the choice made, or it was left unanswered. This may be a result of students often looking at chromatography either by using food colourings, or by using permanent pens where they need to use a different solvent, such as ethanol, where water will not separate the components of the dyes. In this situation, coloured spots are often produced on the finished chromatograms and there is no requirement for students to consider how they could change the practical in order to locate a colourless mixture.

Question 6*

6* The table shows the structure, properties and uses of two carbon allotropes.

	Allotropes	
	Diamond	**Graphite**
Structure		
Melting Point (°C)	3550	3550
Hardness (1 = softest, 10 = hardest)	10	1–2
Electrical Conductivity	Low	High
Uses	drills (used for making holes)	electrodes, lubricants

Explain why diamond and graphite are suitable for the uses that are stated in the table.

Use ideas about the structure and bonding of diamond and graphite in your answer.

....

....

....

....

....

.... **[6]**

Exemplar 1

Dimond has a low conductivity ~~meaning~~ ~~that~~ and is very hard with an exteremely high melting point meaning that it is the ideal substance for drill. Secondly Graphite, Graphite has a high conductivity and a exteremly low saftness making it perfect for a ~~elect~~ lubricant and a electrode, its high melting point is another factor of why it is ideal for this.

This candidate has addressed the question with a response that is a good match to the Level 2 descriptor, achieving 4 marks overall. They have clearly linked the uses of diamond and graphite to the properties listed in the stem of the question. The response is well laid out and communicates the candidate's ideas effectively. In order to move this on to achieve Level 3 the candidate would have needed to include some relevant information about the structure and bonding in both allotropes. This could include statements that make use of the information presented such as 'each carbon atom in diamond is bonded to four other carbon atoms as shown in the diagram'. Or to include some relevant chemical knowledge, for example, 'in graphite there are delocalised electrons that allow it to conduct electricity'. A single correct statement about the structure and bonding for each allotrope would have taken this response from a Level 2 into Level 3 and a mark of six.

Question 7 (a)

7 Crude oil is mainly a mixture of hydrocarbons.

(a) Define a hydrocarbon.

....

.... **[1]**

Although the vast majority of candidates recognised that a hydrocarbon contains the elements carbon and hydrogen, they often described them as being in a mixture, or more significantly did not state that in this class of compound these are the ONLY elements that are present. The range of organic molecules around us means that it is vital that candidates are precise in their definitions of classes of compounds. Many candidates gave responses that were very close to attainting the mark here but did not do so as they did not include the word 'only' in their definition.

Question 7 (b) (ii)

(ii) Complete the sentences to explain how separation occurs in the fractionating column.

Use words from the list.

Atoms	**Cooler**	**Condense**	**Hotter**	**Less**
Molecules	**More**	**Vapourise**		

The mixture of hydrocarbons is heated before entering the column which causes the hydrocarbons to ....

Smaller hydrocarbons reach the top of the column where it is ....

The smaller hydrocarbons have weaker forces between ....

This means they need .... energy to separate.

[4]

This question was accessible to the vast majority of candidates. It was not uncommon to see scores of three or four being consistently given. The most commonly seen error was in the choice made to complete sentence one with 'condense'. Lower attaining candidates usually attempted this question and often scored two marks for correctly completing sentences two and four.

Question 7 (c) (i) and (ii)

(c) The hydrocarbons in crude oil are mostly alkanes. Alkanes all have the general formula:

C_nH_{2n+2}.

Larger hydrocarbon molecules are broken down into smaller hydrocarbon molecules using cracking.

(i) Complete the equation to show the formula of the second product.

$C_{12}H_{26} \rightarrow C_6H_{12}$ + ...

[1]

(ii) Explain why C_6H_{12} is **not** an alkane.

....

.... **[1]**

This pair of questions assessed candidates' ability to apply their knowledge and understanding to an unfamiliar situation. Candidates were presented with the general formula for an alkane and were asked to use it in two contexts. In Question 7 (c) (i) candidates were asked to identify the molecular formula of one of the molecules formed in a cracking reaction. They were given the molecular formula of a large alkane molecule along with the formula of one of the products of the reaction and asked to write the formula of the second product formed. This was often well done with many candidates giving the correct formula. The more common incorrectly seen formula was $C_{18}H_{38}$ which is achieved by adding together the parent molecule along with the fragment given, whereas what they should have done was to subtract the formula of the fragment from the molecular formula of the parent molecule.

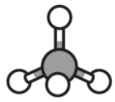
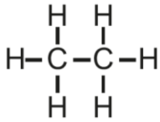
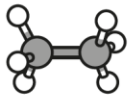
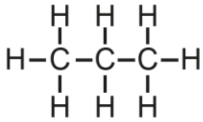
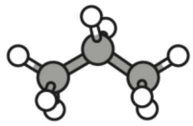
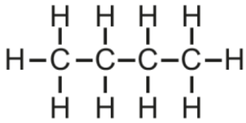
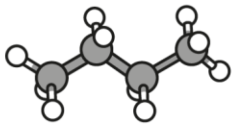
In part (ii) candidates were asked to analyse the formula of the fragment identified in the equation and to suggest a reason why it is not an alkane. There were a large variety of responses here, with no particular error being consistently seen. The more successful candidates on this paper recognised that the formula given did not match to the general formula for an alkane and so scored this mark.

Question 7 (d)

(d) Other types of formula can be used to show hydrocarbon molecules.

The table shows examples of these formulae.

Complete the table.

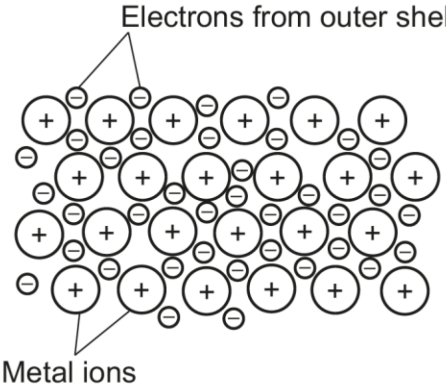
Alkane	**Molecular Formula**	**Empirical Formula**	**Displayed Formula**	**3D Structure**
....	CH_4	CH_4	....	
Ethane	....	CH_3		
Propane	C_3H_8	....		
Butane	C_4H_{10}	....		

[5]

Most candidates tried to answer this question with varying degrees of success. The more competent candidates usually scored three of the marks by correctly naming methane and drawing its displayed formula. They could also recall or determine from the displayed formula, the molecular formula of ethane. Candidates I continue to struggle with the concept of empirical formulae and it was not uncommon to see these two spaces being left blank. Other incorrect responses for the empirical formulae were a result of continuing what candidates perceived to be a trend down the table with CH_2 and CH being written for propane and butane respectively.

Question 8 (a)

8 The diagram shows the structure of a metal.



(a) The properties of a metal depend on its structure.

Complete the sentences to explain the properties of metals.

Use words from the list.

Atoms	**Electrons**	**Ions**

Metals conduct electricity when solid because the .... can move.

Metals are malleable because the .... can slide over each other.

Metals have high melting points because there is a strong attraction between the

.... and the ....

[3]

This was a good question for many candidates. They often scored at least two of the available marks, and it was not uncommon for candidates to score all three marks. A common error was observed in sentences two and three where the word ion was crossed out in one of the sentences and replaced with the word atom. This may have arisen after the candidate had filled in their responses and then thought that because 'atom' was in the list provided that they needed to use it at least once and so made a correction to their original decisions, which unfortunately resulted in them losing one mark.

Question 8 (b) (i)

(b) A student does some experiments to find the reactivities of some metals.

(i) In one experiment, they add a piece of zinc to a blue aqueous solution of copper ions.
They see a reddish metal formed and the blue solution fades to colourless.

$$Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$$

Complete the sentence to explain how this reaction shows that zinc is more reactive than copper.

Put a (ring) around the correct option.

Zinc is more reactive than copper because it **gains / loses / shares** electrons more easily than copper.

[1]

The most commonly seen choice made by candidates here was to select 'gains' from the list provided. This was probably for the same reasons as identified in Question 1 (a) (ii) and 1 (b), as they have a misconception that the formation of a positively charged species involves the addition of electrons rather than the loss of electrons, and this further reinforces the need for students to write lots of examples of ion formation for metals and non-metals when they begin to study ideas on atomic structure.

Question 8 (b) (ii)

(ii) The table shows the student's results from the other experiments:

	Cu^{2+}(aq)	Fe^{2+}(aq)	Mg^{2+}(aq)	Ag^{+}(aq)
Cu(s)		No change	No change	Change
Fe(s)	Change		No change	Change
Mg(s)	Change	Change		Change
Ag(s)	No change	No change	No change	

Write down the metals in order of reactivity.

Most reactive ....

....

....

Least reactive ....

[2]

In this question, candidates were being asked to analyse the data presented to identify trends. Most correctly identified magnesium as being the most reactive metal, but occasionally reversed the order of copper and silver. The mark scheme allowed for this; provided that iron was placed above copper in their list then they could still score one mark. Another way for candidates to score one mark was to recognise that magnesium was the most reactive and that silver was the least reactive, so that if they reversed the order of iron and copper then they could still score one mark. The net effect of these two options was that very many candidates scored at least one mark on this question and very few candidates did not score.

Question 8 (c) (i)

(c) Another student plans an experiment to find the order of reactivity of some metals by adding dilute acid to the metals. The general equation for the reaction between a metal and an acid is:

Metal + acid $\rightarrow$ salt + hydrogen

(i) How will the results of their experiment show the order of reactivity of the metals?

....

....

.... **[2]**

This question was perhaps the most difficult for candidates to be given marks on. Responses often suggested that the order of reactivity was related to the number of products being made, rather than to what they could see happening in the experiment. The two options available were linked to observations that could be made as the reaction proceeded. Therefore the idea of a greater rate of effervescence, e.g. 'more bubbles would be seen with a more reactive metal' or that the metal dissolves quicker, e.g. 'a more reactive metal disappears faster' were the expected responses and these did not appear very often. A commonly seen incorrect response was to state that more 'salt' would be made, which is something that cannot be seen from observing the reaction directly.

Question 8 (c) (ii)

(ii) Suggest why this method of adding metals to acid is not suitable for finding the reactivity of all metals.

....

.... **[1]**

Most candidates were credited with this mark. They knew that not all metals react with acids and so were able to give this as a reason why the method was unsuitable in determining the order of reactivity of all metals. Some candidates were able to receive this mark for stating that a named metal, e.g. gold would not react with acids so could not be placed in an order of reactivity.

Question 9 (a) (ii)

9

(a) **Table 9.1** shows the diameters of some particles.

Table 9.1

Particle	Diameter (m)
Carbon atom	1.54×10^{-10}
Fullerene molecule	1.10×10^{-9}
Silver atom	2.88×10^{-10}
Platinum nanoparticle	1.00×10^{-8}

(ii) Write down the particles in order of diameter.

Smallest ....

....

....

Largest ....

[2]

This was the first of two questions that were overlap questions with the higher tier paper. Again there were options available to candidates that allowed them to score marks on this question, so many candidates did score at least one mark here. The most commonly seen error was for candidates to completely reverse the order of the particles, i.e. platinum nanoparticle as the smallest particle and carbon atoms as the largest of the particles. Where this happened then unfortunately no marks were possible. One mark was given if they recognised that carbon atoms were the smallest or that the platinum nanoparticle was the largest, and this benefitted a number of candidates. The main source of confusion for candidates was the use of standard form in detailing the diameter of the particles, and this became obvious where they tried to place the particles in order by using the values for the diameters from table 9.1, believing 2.88×10^{-10} was the largest.

Question 9 (b)

(b) Nanoparticles make effective catalysts because they have a high surface area to volume ratio.

Table 9.2 shows the surface area to volume ratio of some different sized particles.

Table 9.2

	Nanoparticle	**Particle of Fine Powder**	**Particle of Coarse Powder**
Size of Particle (nm)	60	600	6000
Surface Area to Volume Ratio	0.1	0.01	0.001

Describe the relationship between the size of a particle and its surface area to volume ratio.

....

....

....

.... **[2]**

A commonly seen response on the foundation tier resulted in candidates failing to score any marks, and it was not necessarily that they did not spot the pattern but that they did not express their ideas effectively. Typically what was seen were responses of the type 'the bigger the particle the smaller the surface area.' This was an incomplete response and was not deemed to be creditworthy.

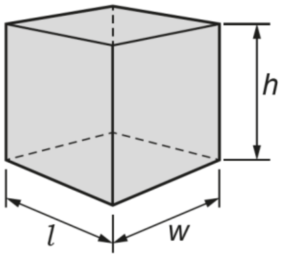
Exemplar 2

The smaller the size of the particle the bigger the surface area ~~that~~ to volume ratio will be

This exemplar was typical of responses from candidates at this level. They were able to spot that the size of the particles was increasing, the surface area to volume ratio was getting smaller/decreasing. Where they did not score was in recognising the trends in the data. The particle size was increasing by a factor of 10 each time while the surface area to volume ratio was decreasing by a factor of 10 each time.

Question 9 (c)

(c) The nanoparticle shown is a cube. This nanoparticle has a volume of 1000 nm^3.



NOT TO SCALE

Calculate the surface area of the nanoparticle.

Use the formula: surface area = 6 × (h × w)

Surface area = ... nm^2
[3]

For candidates at foundation tier this proved to be a very challenging question and was the main source of questions that were left unattempted. Very few candidates recognised the need to take the cube root of the volume in order to determine the size of one edge of the cube. Without this they could not score full marks as this value was needed to correctly calculate the surface area of the cube. Typical attempts to determine this value saw 1000/3 = 333.3 as one possible value, also 1000/6 = 166.6 as another regularly seen value. Where these values were then inserted correctly into the equation given to calculate the surface area, then one mark could be given for a correct substitution, and a second mark was possible if it was then correctly evaluated.

Question 10 (a)

10 A student is investigating the reaction between calcium hydroxide and hydrochloric acid.

$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

(a) They want to find the temperature change during the reaction.

1 g masses of solid calcium hydroxide are added one by one to 50 cm^3 of dilute hydrochloric acid in a plastic cup.

Describe **two** measurements the student needs to make **and** the apparatus needed to make the measurements.

1. ....

....

2. ....

....

[2]

Candidates who had made good use of their time working through the paper often scored both marks here, but where there was evidence to suggest that candidates were beginning to struggle for time the responses produced appeared to be hurried. Good responses often saw candidates correctly state that the temperature needed to be recorded and that a thermometer was required for one mark. They often then either gave the need for a measuring cylinder to measure the volume of acid, or they stated the need for a balance to determine the mass of solid, for a second mark. Candidates who were pushed for time often gave very brief responses such as ‘ record volume of acid and temperature of the solution’ or ‘use a thermometer and a measuring cylinder’ both of these responses were acceptable for one mark.

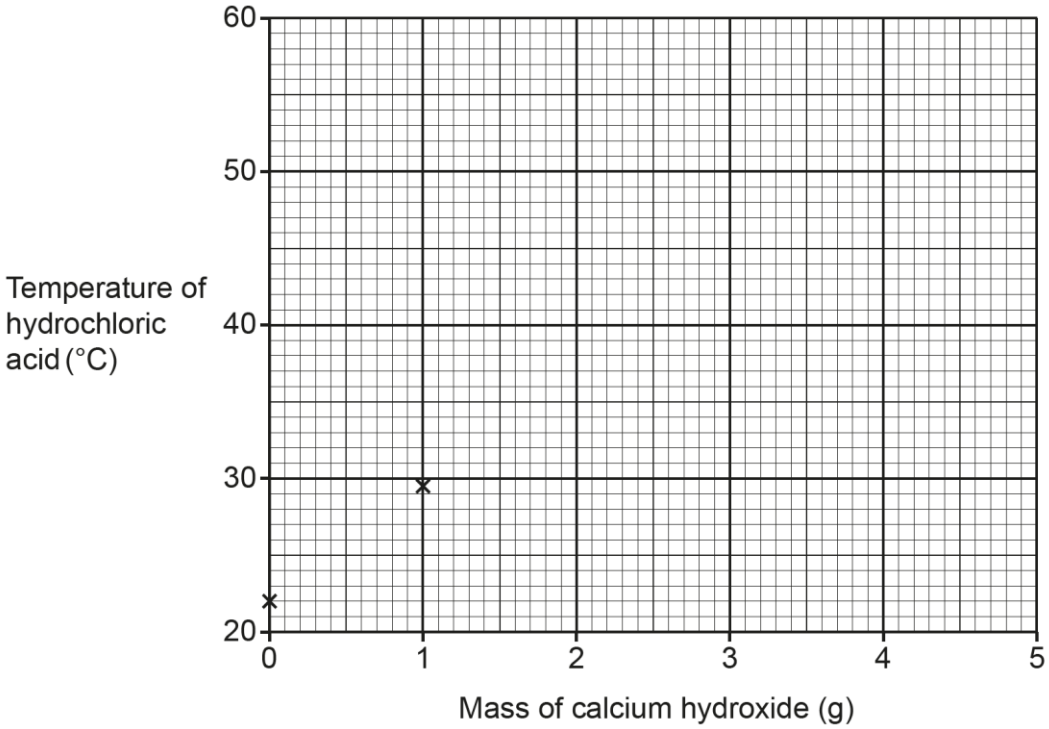
Question 10 (b) and (c)

(b) The table shows the student's results:

Mass of calcium hydroxide (g)	Temperature of hydrochloric acid (°C)
0	22.0
1	29.5
2	37.0
3	44.5
4	52.0
5	59.5

Plot the results from the table on the graph.

Two points have already been plotted. **[2]**



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

This pair of questions proved to be very accessible and successful to candidates at this level. They clearly plotted the required points accurately and then used a ruler to draw the correct line of best fit that did not go through 0,20. By doing this many candidates scored all three marks on these two sub-questions.

Question 10 (e) and (f)

(e) Calculate the **change** in temperature if 3.8 g of calcium hydroxide is added to the hydrochloric acid.

Use the graph.

Temperature change = ... °C **[2]**

(f) Calculate the change in thermal energy when 3.8 g of calcium hydroxide is added to 50 cm^3 of hydrochloric acid.

Use the formula:

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

1 cm^3 hydrochloric acid = 1.02 g

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

The final pair of questions on this paper were about interrogating the graph to determine the temperature change when a non-integer mass of calcium hydroxide was used in the reaction, and subsequently to calculate the change in thermal energy of the reaction. In part (e) many candidates were able to draw construction lines on their graph that produced an intercept at about 50 – 51°C for the temperature of the hydrochloric acid, but then did not calculate the correct temperature change by subtracting the starting temperature (22°C) from their intercept value. Candidates then had to use their value from (e) as part of their calculation in (f)

Where candidates had not calculated the temperature change correctly in (e), but had simply used their intercept value, then they lost one mark in part (e) but could still score all three marks in part (f).

Exemplar 3

(f) Calculate the change in thermal energy when 3.8 g of calcium hydroxide is added to 50 cm^3 of hydrochloric acid.

Use the formula:

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

1 cm^3 hydrochloric acid = 1.02 g

$4.2 \times 28 \times 51 = 5997.6$

$50 \times 1.02 = 51$

Change in thermal energy = 5997.6 J **[3]**

Exemplar 3 shows this being carried out correctly and is well laid out making it easy to identify where marks could be given.

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