Qualification Accredited

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 2019 series

Version 1

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. 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.

Paper 2 series overview

J260/02 is one of the eight examination units for the new revised GCSE 9 - 1 level examination for GCSE 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 completing the required practical element of the course.

Candidate performance overview

Candidates who did well on this paper, generally demonstrated the following characteristics

- Use ideas about the atomic structure in Q1, Q6b, Q6c(i) and (ii).
- Demonstrate knowledge and understanding relating to practical techniques, Q2a,b(i) and (ii).
- Produced a clear and concise answer to the Level of Response question, Q3d.
- Performed standard calculations showing clear working, and where appropriate conversion to the required number of significant figures, Q2b(iii) and (iv), and Q3c.
- Interpret data and draw conclusions, Q1c(i), Q3d, 4c(iii) and (iv).

Candidates who did less well on this paper, generally demonstrated the following characteristics

- Struggled to make appropriate links between energy, temperatures and/or intermolecular forces in describing changes of state, Q5b(ii), Q9c(i) and (ii), and Q10b all parts.
- Found it difficult to apply their knowledge from one concept in another context, Q8.
- Often did not attempt questions addressing mathematical skills.

There was no evidence that candidates had struggled to complete the paper within the time allocated, scripts where there was no response to the final question were also scripts where there was evidence that candidates had struggled to access/cope with the maths skills assessed within the paper.

Question 1 (a)

1 Lithium metal is a group 1 element. Lithium atoms have the electron arrangement 2.1.

(a) Which of the following statements about the atoms of **all** group 1 elements are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	**True**	**False**
They all have 2 electrons in their first shell.		
They all have 1 electron in their outer shell.		
They all have the same number of electrons.		
They all have the same number of electron shells.		

[2]

Question 1 (b)

(b) The elements on the left of the periodic table are all metals.

Which two statements about atoms of these elements are **true**?

Tick (✓) **two** boxes.

They have a small number of electrons in their outer shell. ☐

They do not contain electrons. ☐

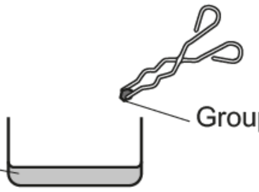
They lose electrons easily. ☐

They form covalent bonds by gaining electrons. ☐

[2]

Question 1 (c) (i)

(c) Beth is a chemistry teacher. She does experiments to show the reactivity of the Group 1 metals with water.



She places a small piece of lithium into the water with universal indicator and records her observations. She repeats this method with sodium and then potassium.

Beth's observations are shown in the table.

Metal	**Observations**
Lithium	Fizzes slowly. Indicator turns blue.
Sodium	Fizzes quickly. Sodium melts and moves quickly on surface of water. Indicator turns blue.
Potassium	Fizzes quickly. Potassium melts and purple flame formed. Indicator turns blue.

(i) How do the observations show the trend in reactivity going down Group 1 of the Periodic Table?

....

....

.... **[2]**

Most candidates found Questions 1(a) and 1(b) to be a straightforward introduction to this paper and scored marks on both questions. They recognised the relevant features of Group 1 elements and often scored both marks on part (b) even if a mark had been lost in part (a). A common incorrect response for part (a) was to tick the box stating that statement 4 was true when it is false. In part (c)(i) most candidates scored 2 marks as they correctly stated that the speed of movement as identified by the fizzing, increased going down the group and that this was evidence for an increase in reactivity, or they correctly stated the trend without reference to any of the observations and this was allowed for 1 mark.

In 1c(ii) most candidates scored at least 1 mark with the most common incorrect response being to suggest that the fizzing was due to the production of oxygen rather than hydrogen. Very few candidates did not score any marks on this question.

Question 2 (a), 2b(i) and 2b(ii)

(ii) Jack finds that his method makes very small crystals.

How could he change step **D** so that he makes larger crystals?

....

....

.... **[2]**

This question was designed to assess candidates' knowledge of practical techniques and their ability to link their experiences of the required practicals element of the course to an unfamiliar situation.

In part (a) many candidates scored all 3 marks and the only common error evident was in choosing 'dissolve' rather than 'evaporate' from the final pair of options.

Part (b)(i) was designed to test whether candidates could sequence events in order to determine the percentage of pure salt in the mixture. Most candidates were credited at least 2 marks as they correctly identified the need to weigh the mixture before adding water and stirring, i.e. step F somewhere before A, and then the need to heat to evaporate all the water in step D. Provided that these three letters were in this order even if B,C or E was interspersed incorrectly between them, then they could be credited 2 marks. Very few candidates did not gain at least 1 mark on this question.

Finally, in (b)(ii) candidates were required to demonstrate that they could identify an issue with a procedure and to then rectify the problem. Many candidates made reasonable suggestions but often came unstuck by evaporating the solution to dryness. However, in the exemplar shown, this candidate has identified the need for partial evaporation and then allowing the crystals to form slowly.

Exemplar 1

he could heat the solution to some extent

but not evaporate all of the water, and

leave it to form larger crystals **[2]**

Question 2 (b) (iii) and 2(b) (iv)

(iii) Jack used 10.0 g of the mixture for his sample.

He used a dish to weigh the pure salt he made.

Mass of empty dish = 50.0 g

Mass of dish with pure salt = 58.4 g

Calculate the **mass of pure salt** he made.

(iv) The percentage of pure salt in the mixture can be calculated using the formula:

$$\text{Percentage} = \frac{\text{mass of pure salt}}{\text{mass of mixture}} \times 100$$

Calculate the **percentage** of pure salt in the sample.

Percentage = ... % **[2]**

This was a two-step calculation that the vast majority of candidates attempted. There were very few unanswered responses evident. In part (iii) the expected answer was 8.4g and this was usually obtained.

In part (iv) candidates then had to use their answer from (iii) to calculate the percentage of pure salt using the equation provided, and again the vast majority of candidates did this successfully arriving at the expected answer of 84%. However, there were a number of candidates who used 58.4g as their mass of mixture and so did not gain any marks here.

Question 3 (a),3 (b) and 3 (c)

(c) A sample of PVC has a mass of 12.0 g and a volume of 8.0 cm^3.

Calculate the density of PVC.

Density = ... g/cm^3 **[2]**

This question was designed to assess candidates' abilities to analyse data and draw appropriate conclusions.

In part (a) they were presented with a table of data and asked to identify the two metals based on the properties listed. This was usually done well although a significant proportion of candidates did not gain any marks as they incorrectly identified graphite as a metal.

In part (b) candidates were told that 'graphite' tennis rackets are made from a polymer combined with graphite fibres and were asked to state what type of material this was, the correct response of composite was often identified, although a significant proportion of candidates thought that the mixture resulted in the production of a ceramic material.

In part (c), they then were given some data about the mass and volume of some PVC and were asked to calculate the density of the material, most candidates did attempt this but many did not gain a mark as they multiplied the values rather than divide them giving an answer of 96 (g/dm^3) or in some cases an answer of 6144 (from 12×8^3) which suggests that they did not fully understand the units provided.

Question 3 (d)

(d)* A company decides to make a new tennis racket. They want the new racket to be stiff, light and strong.

The company considers using **steel**, **aluminium alloy** or **graphite** for the new racket.

Decide which of these three materials is the best choice for the racket by discussing their advantages and disadvantages.

Use data from the table to support your answer.

....

....

....

....

....

.... **[6]**

This question is intended to allow candidates the opportunity to demonstrate their ability to construct an answer and to communicate their knowledge and understanding of the properties of materials. They should have used the table of data from (a) to identify the relevant materials and their advantages and/or disadvantages, and to then make a decision on the best material to use for the construction of a new tennis racket.

This question illustrated that candidates of all abilities were able to engage with the stimulus material provided and the mark scheme gave them credit for attempting to communicate their ideas in a way that allowed them to gain some marks.

Exemplar 2

Steel is the most stiff and is quite strong, ~~it also has the highest~~ but it has the highest density, meaning it is heavy. This makes it unsuitable. Aluminium alloy has a Low Strength and Stiffness, which makes it unsuitable Despite its good weight. Graphite would be the most Suitable, it has a good strength and stiffness and is light weight.

At Level 2, again candidates had to have chosen graphite as the best material to use, they also needed to have identified an advantage and disadvantage for one of the other materials. The alternative route to Level 2 was a very popular route with candidates, whereby they often identified an advantage for each material, without necessarily identifying a disadvantage, and again decided that graphite was the best material. See Exemplar 3.

Exemplar 3

The best material they should use is graphite as it has a high amount of stiffness (GPa) and it has a light density of 2.0g and it has a large amount of strength. Compared to steel (iron alloy) graphite is better because steel (irong alloy) is way more heavier and has less strength (MPa) compared to graphite. and steel also has a high stiffness (GPa) which may not be great for the tennis player as they some flexibility.

Steel is the most stiff and is quite strong, ~~it also has the highest~~ but it has the highest density, meaning it is heavy. This makes it unsuitable. Aluminium alloy has a low strength and stiffness, which makes it unsuitable. Despite its good weight. Graphite would be the most suitable, it has a good strength and stiffness and is light weight.

At Level 1, candidates of lower ability were able to gain marks here if they could give an advantage and disadvantage for one of the materials or choose graphite with a simple reason. See Exemplar 4.

Exemplar 4

In terms of strength, graphite is the strongest. However graphite is the least dense. Steel is the most dense and also has the highest amount of stiffness. I think steel would be the best choice for the racket as it is the most stiff and has high strenth along with the most density.

Aluminium alloy and graphite wouldn't be suitable as they have more disadvantages to advantages making the racket not as long lasting and not suitable for its expectations. [6]

Questions 4 (a), (b), (c)(i), and (c)(ii)

4 Mia adds magnesium to dilute hydrochloric acid.

(a) Complete the word and balanced symbol equations for the reaction between magnesium and hydrochloric acid.

magnesium + hydrochloric acid → .... + hydrogen

.... + ... HCl → $MgCl_2$ + ...

[3]

In Q4a, this question proved challenging to many of the candidates of lower ability entered for this paper. Although many correctly identified Magnesium Chloride as the missing product, they struggled to construct the balanced symbol equation, with the most commonly seen error being the formula for hydrogen being given as 2H rather than H_2.

In Q4b, candidates were given a list of various pieces of apparatus that could be used for measurements in science and were asked to choose the most appropriate for measuring a volume of hydrogen gas, there were many candidates who correctly identified the gas syringe as being the most suitable, but a number of candidates incorrectly chose the beaker or pipette which would be suitable for measuring volumes of liquid but not gas.

Questions 4c(i) and 4c(ii) were multiple-choice questions that asked candidates to interpret the graph provided. Many candidates appeared to misunderstand the type of graph as their choices indicated that they appeared to think that this was similar to a velocity – time graph from physics. The most commonly seen response in (i) was option 3 – the reaction is speeding up, and in (ii) was option 4 – the reaction is at a constant rate. Therefore, it appears that centres may wish to make sure that when covering rates of reaction with students, they try to address this commonly seen misconception.

Question 4 (c) (iii)

(c) She plots her results on a graph.

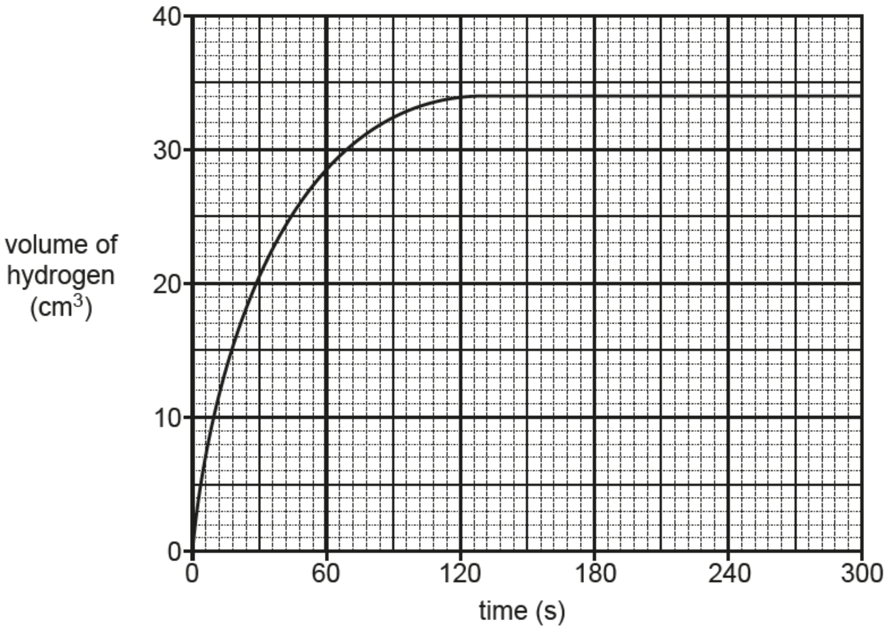


Fig. 4.1

Question 4 (c) (iv)

(iv) Using **Fig. 4.1**, what is the total volume of hydrogen collected in this experiment?

Total volume = ... cm^3 **[1]**

This pair of questions tried to assess candidates' abilities to interpret data from the graph provided. Most candidates correctly identified that the reaction had stopped at 30 seconds, and that the volume of gas collected was $34cm^3$, although a small number of candidates gave a value for this of $38cm^3$ through misreading of the scale on the vertical axis. Again, this type of question proved to be successful in engaging with the students as there were very few scripts where these two sub questions had not been attempted.

Question 5 (a) (i), (a) (ii), (b) (i) and (b) (ii)

5 Zinc is made by heating zinc oxide with carbon.

zinc oxide + carbon → zinc + carbon dioxide

$2ZnO(s) + C(s) \rightarrow 2Zn(g) + CO_2(g)$

(a) (i) The zinc oxide is reduced by the carbon to make zinc.

What does **reduced** mean in this situation?

Tick (✓) **one** box.

The mass of zinc oxide increases. ☐

The zinc oxide reacts with air. ☐

Zinc oxide loses energy. ☐

Zinc oxide loses oxygen. ☐

[1]

(ii) Zinc can be made by heating zinc oxide with carbon.

Aluminium **cannot** be made by heating aluminium oxide with carbon.

Which two statements explain why?

Tick (✓) **two** boxes.

Aluminium is less reactive than zinc. ☐

Aluminium is more reactive than carbon. ☐

Aluminium oxide is very rare. ☐

Zinc is less reactive than carbon. ☐

Zinc oxide melts when it is heated. ☐

[2]

(b) Aluminium is made by passing electricity through molten aluminium oxide.

(i) What state is molten aluminium oxide in?

Put a (ring) around the correct answer.

gas **liquid** **solvent** **solution**

[1]

Fig. 5.1 shows the ions in molten aluminium oxide.

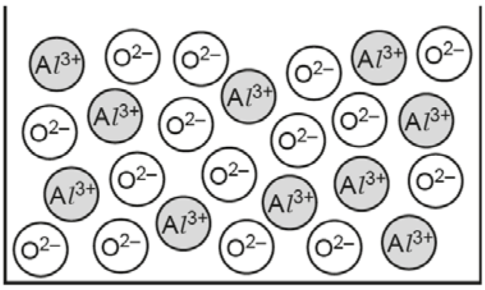


Fig. 5.1

(ii) Molten aluminium oxide conducts electricity. Solid aluminium oxide does not.

Explain why, using **Fig. 5.1** to help you.

....

.... **[2]**

This question was looking at candidates' knowledge and understanding about the reactions of metals and in particular about how aluminium is extracted.

Questions 5a(i) and (ii)were a pair of multiple-choice questions looking at redox and reactivity. Most candidates showed their understanding about the term reduction as they correctly identified that in the example given this is illustrated by the zinc oxide losing oxygen.

In part (ii) there were quite a few candidates who did not gain marks as they did not follow the instruction provided in the rubric of the question to tick the **two** boxes, and so only ticked one box, often one of the two correct choices so gained one mark rather than the two that were available. Centres should make sure that candidates are given examples of this type of question to try to prevent these types of marks from being lost to candidates.

Question (b) parts (i) to (iii) all addressed the extraction of aluminium from aluminium oxide. Part (i) presented candidates with a diagram, Fig 5.1 above, and asked them to identify the state for the substance. Most candidates correctly identified that the compound was a liquid. Having done this they were then asked to explain why molten aluminium oxide conducts electricity. There were a variety of responses given that did not score as they did not identify that the compound contained charged particles, or ions, even though they had got the diagram to help them. Many candidates suggested that there were free electrons in the molten substance, or they identified that the aluminium ions in the molten state were positively charged but then stated that in the solid they were negatively charged which is incorrect. Finally, many candidates did not appreciate that in the molten state the particles are able to move and so can carry a charge through the ions.

Exemplar 5 shows a response where the candidate has correctly identified that the particles are free to move in the molten aluminium oxide and so are credited marking point 2, had they included the word 'charged' before the word particles in their description then they would have been credited marking point 1 also.

Exemplar 5

because the particles in molten Aluminium Oxide are free to move and are not tightly packed together. **[2]**

Question 5 (b) (iii)

(iii) A positive and negative electrode are used to pass electricity through molten aluminium oxide. A product is made at each electrode.

Draw lines to join each **electrode** with the correct **product** formed.

Use **Fig. 5.1** to help you.

Electrode	Product made
	Aluminium
Negative	Aluminium oxide
	Water
Positive	Hydrogen
	Oxygen

[2]

This question was surprising in that the most commonly seen incorrect response was to draw a line from the positive electrode to aluminium oxide, even where they had correctly identified that aluminium is attracted to the negative electrode. Where candidates did not gain marks at all here was often as a result of drawing too many lines from the boxes on the left to the boxes on the right. More than one line from a box on the left was ruled as being a contradiction as often one choice was correct and another was incorrect.

Question 6 (a) and 6 (b)

6 Atoms contain a nucleus surrounded by electrons.

(a) The nucleus contains protons and neutrons.

Which statements about the nucleus are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	**True**	**False**
Most of the mass of the atom is in the nucleus.		
Neutrons have a positive charge.		
The nucleus has an overall positive charge.		
The nucleus takes up most of the space of the atom.		

[3]

(b) An atom of strontium has an atomic number of 38 and a mass number of 88.

How many protons, electrons, and neutrons are in an atom of strontium?

Protons = ...

Electrons = ...

Neutrons = ...

[2]

Part (a) was well answered by most candidates. The only common incorrect choice was at option 1 where candidates ticked 'False' when this is a true statement about the nucleus of an atom.

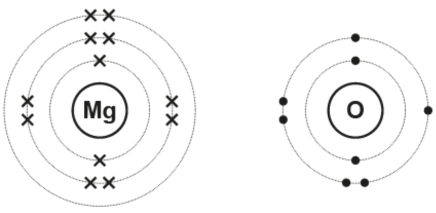
Part (b) proved to be challenging to most candidates and there were a significant number of scripts where this question had not been attempted. This may have been because of the element used, strontium, as it may be unfamiliar to candidates, however, the question posed is one that they should have tackled many times in dealing with the ideas about atomic structure and isotopes. Where they did correctly identify that there were 38 protons a common incorrect response had them stating that there were 38 neutrons and 50 electrons. This would have lost candidates both marks here. Another commonly seen response to this question had candidates giving 38 protons, 50 neutrons but only two electrons. Presumably this comes from looking at the periodic table and identifying strontium as being in Group 2, However, this response does score 1 mark for correctly determining that there are 50 neutrons in the nucleus of a strontium atom.

Question 6 (c) (i)

(c) Magnesium atoms react with oxygen atoms to form magnesium oxide.

Magnesium oxide contains magnesium ions and oxygen ions.

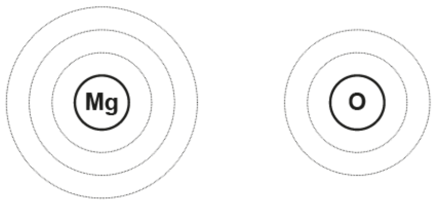
Fig. 6.1 shows the number and arrangement of electrons in a magnesium atom and an oxygen atom.



magnesium atom **oxygen atom**

Fig. 6.1

(i) Complete **Fig. 6.2** to show the number and arrangement of electrons in a magnesium **ion** and an oxygen **ion**.



magnesium ion **oxygen ion**

Fig. 6.2 **[2]**

Question 6 (c) (ii)

(ii) What are the charges on each ion?

Choose from this list.

+1 –1 +2 –2 +3 –3

Charge on magnesium ion = ...

Charge on oxygen ion = ...

[2]

In Question 6(c)(i), the most commonly seen incorrect response was where candidates simply re-copied the electron arrangements for the magnesium and oxygen atoms onto the ions gaining no marks. However, where candidates did attempt to draw an appropriate diagram they often gained marks for the oxide ion by filling up the outer shell, but did not gain marks for magnesium as they often did not remove both outer electrons and left a single unpaired electron behind.

In part (ii) they then had to identify the charge on each ion. Most gained at least one mark as they identified at least one of the ions with the correct charge, even if this did not always match to their diagram, but as the marks were independent of one another then this was allowed. The most commonly seen incorrect pair of responses had magnesium as -2 and oxygen as +2 presumably as a result of identifying that the respective atoms had lost two electrons (Mg^{-2}) or gained two electrons(O^{+2}).

Question 7 (a)

7 Some metals react with bromine to form metal bromides.

(a) The table shows information about some metal bromides.

Complete the table by filling in the blank spaces.

Name of bromide	Metal ion	Bromide ion	Formula of metal bromide	Relative formula mass
Potassium bromide	K^+	Br^-	KBr	119.0
Rubidium bromide	Rb^+	Br^-	RbBr	....
Calcium bromide	Ca^{2+}	Br^-	....	199.9
Strontium bromide	Sr^{2+}	Br^-	$SrBr_2$	....

[3]

More able candidates often gained at least two marks here as they correctly calculated the Relative Formula Mass for rubidium bromide as 165.4 and gave the formula of calcium bromide as $CaBr_2$. Weaker candidates often gained the first mark only as they identified the atomic masses from the periodic table and were able to use them correctly. Common incorrect responses included using atomic number rather than atomic masses, giving the formula of calcium bromide as CaBr, or only using the mass of one bromine atom when determining the formula mass of strontium bromide.

Question 7 (b)

(b) Metal bromides have high melting points.

Which statements about metal bromides are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	**True**	**False**
Bonds between metal ions and bromide ions are strong.		
Metal bromides have covalent bonds.		
When metal bromides melt they lose electrons.		
It takes a lot of energy to separate the ions.		

[2]

This question was well answered by many candidates as they recognised that bromine was a non-metal and could correctly identify that this meant that it should be an ionic compound with corresponding properties and gained at least 1 mark here if not 2. The only common error was to tick option 3 as being true rather than false.

Question 8 (a) (i) and (a) (ii)

(ii) Ali then adds the enzyme to different concentrations of hydrogen peroxide.

He finds that the reaction is faster when the concentration of hydrogen peroxide solution is higher.

Explain why the reaction is faster.

Use ideas from the particle model in your answer.

....

....

....

.... **[2]**

Question 8 proved to be particularly challenging to students. They struggled to link ideas from a topic that many associate with biology, enzymes, to a chemistry concept. In part (a)(i) they did often identify that enzymes are catalysts and so gained this mark, however, in a(ii) responses seldom addressed the question. Most discussed ideas about enzymes rather than how changing concentration affected rate. So, most candidates gain no marks on this question. However, more able candidates who were able to link ideas together did gain at least one mark here often for the idea of more frequent collisions. See Exemplar 6.

Exemplar 6

The enzyme is already a catalyst so it will therefore speed up the reaction and when the concentration is ~~increased~~ higher the rate of reaction also increases as there are more particles so there are more frequent collisions **[2]**

Question 8 (b) (i)

(b) Ali does more experiments.

He makes some solutions of hydrogen peroxide with different pH values.

(i) Describe **one** method of measuring the pH of each solution.

....

....

.... **[2]**

Candidates struggled with this question, they did not appreciate that their choice of indicator had to be able to identify the pH value, rather than just stating of the solution was an acid or an alkali. So many candidates gave litmus paper, litmus solution, methyl orange or phenolphthalein as their choice and then a colour change that identified the substance as an acid or alkali. These types of responses gained no marks. In order to gain any marks candidates should have either used an electronic method of measurement, e.g. pH meter and read off the scale, or use Universal Indicator and compare the colour produced against a colour chart or pH scale(chart). Where candidates did give Universal Indicator as their preferred means of measuring the pH they occasionally did not gain the second mark as they simply stated that the colour would tell you if it was acid or alkali with no reference to a colour chart or pH scale. See Exemplar 7.

Exemplar 7

Add a few drops of universal indicator into each solution and then use the PH scale to measure **[2]** by looking at the colour the solution has become.

Question 8 (b) (ii)

(ii) Ali adds the enzyme to these solutions of hydrogen peroxide with different pH values.

He finds that the rate of reaction **increases** when pH values increase from 1 to 6.

He finds that the rate of reaction **decreases** when pH values increase from 6 to 7.

Use ideas about enzymes to explain these results.

....

....

.... **[2]**

Most candidates who attempted this question did not gain any marks as they simply re-phrased the information presented to them in the stem of the question. The only commonly gained response would have been one where the candidate suggested that the reaction rate decreased as a result of the enzyme becoming denatured. Most did not appreciate that the enzyme had an optimum pH of 6, not a range, e.g. pH 6-7, as at either side of this value the rate would decrease.

Question 9 (a)

9 James uses charcoal as a fuel for his barbecue.

Charcoal is a form of carbon. When charcoal burns in plenty of oxygen it forms carbon dioxide.

$C(s) + O_2(g) \longrightarrow CO_2(g)$

(a) How could you test that the gas formed is carbon dioxide?

....

....

.... **[2]**

This question is essentially about a common gas test that students should have met at some point in KS3 or KS4 in a practical context. Many students did not gain marks as they stated that the test would be to introduce a lit splint into the gas and the result being that it would be extinguished. While this may be true it is not the recognised test for carbon Dioxide, as Nitrogen would also give this result for this test.

The only acceptable responses here are those identified in the mark scheme and in the programme of study as part of the required practical element on the identification of gases, i.e. bubble through limewater and it should go cloudy/milky/give a white precipitate.

Question 9 (b)

(b) Explain why burning charcoal **without** enough oxygen can cause a health hazard.

....

....

.... **[2]**

This proved to be surprisingly difficult to candidates. Most gave answers that stated that the smoke would be the major hazard as it would be harmful, this was not accepted as it was too vague. We were looking for evidence of particular health issues being identified. The question tried to guide students into the correct area as it gave them carbon in the introduction before the equation in (a), and so students should have identified that in a lack of oxygen Carbon Monoxide will be produced, they were also credited if they identified that in the smoke there were carbon particles(particulates). For both of these they needed to add an associated health hazard, e.g. Carbon Monoxide is toxic/poisonous (fatal/deadly), or that carbon particles could be linked to asthma or lung cancers. For both of these the health hazard had to be linked to the cause correctly so candidates could not just offer a 'mix and match' type of response.

Question 9 (c) (i), (c) (ii) and 9 (d)

(c) **Fig. 9.1** shows the reaction profile for charcoal burning in air.

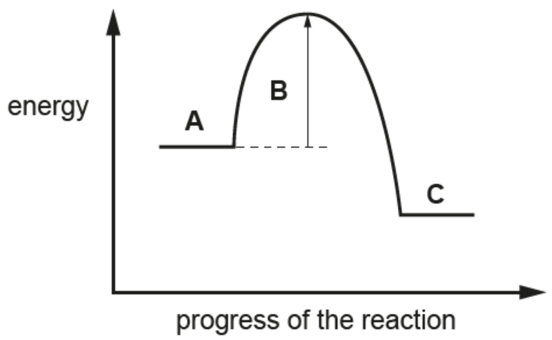


Fig. 9.1

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

Letter	Label
A	Reactants
B	Products
C	Energy change of reaction
	Activation energy

[2]

(ii) Complete the sentences to explain what **Fig. 9.1** shows.

Use words from the list.

You may use each word once, more than once, or not at all.

less than **more than** **the same as**

given out **taken in** **endothermic** **exothermic**

The energy of the reactants is .... the energy of the products.

This means that energy is .... and so the reaction is

....

[2]

(d) James uses a firelighter.

The firelighter burns with a hot flame which makes the charcoal start to burn.

Which two statements explain how the firelighter makes the charcoal start to burn?

Tick (✓) **two** boxes.

More charcoal particles have enough energy to react.	☐
The activation energy decreases.	☐
The burning firelighter takes energy from the charcoal.	☐
The charcoal particles increase in energy.	☐
The reaction becomes more exothermic.	☐

[2]

Questions 9(c) and 9(d) addressed the area of energetics. Candidates often struggle to communicate their knowledge and understanding in this area effectively and so this approach was adopted to try to identify what candidates knew more effectively.

In (c)(i) most candidates gained one mark as they identified that A and C were linked to the reactants and products correctly, they often gave B as being the energy change for the reaction or drew two lines from B to both energy statements.

In (c)(ii) they were presented with a pair of sentences and had to fill in the blank spaces using the words provided. Many candidates gained at least 1 mark as they correctly identified the required words to complete the second sentence correctly, or they correctly completed the first sentence and the first element of the second sentence but then entered the term endothermic in the final space rather than the correct term exothermic. On the whole most candidates gained at least two marks on part (c) with a significant number gaining three.

In (d) Many candidates identified the first box correctly to gain one mark, but then occasionally did not tick any other box as required in the question. A common incorrect response here was that candidates ticked box 3 rather than box 4.

Question 10 (a) (i) and (a) (ii)

10 Alkanes are a family of hydrocarbons in crude oil. They all have the same general formula, C_nH_{2n+2}.

Table 10.1 shows some information about alkanes.

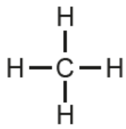
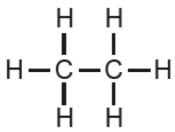
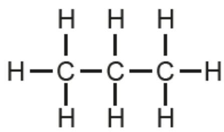
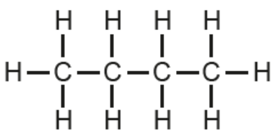
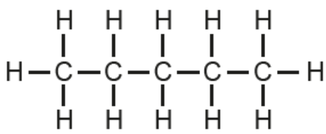
Alkane	Number of carbons	Molecular formula	Empirical formula	Structural formula	Melting point (°C)	Boiling point (°C)
Methane	1	CH_4	CH_4		–182	–161
Ethane	2	C_2H_6	CH_3		–183	–88
Propane	3	C_3H_8	....		–188	–42
Butane	4	C_4H_{10}	....			0
Pentane	5	C_5H_{12}	C_5H_{12}		–130	36
Hexane	6	....	C_3H_7	....	–95	

Table 10.1

(a) (i) Complete the blank spaces in **Table 10.1** to show the missing formulae. **[3]**

(ii) Which statements about a **structural formula** are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
It shows the simplest ratio of atoms in a molecule.		
It shows how many atoms are in a molecule.		
It shows how the atoms in a molecule are arranged.		
It shows the molecule in 3D.		

[2]

Questions 10 and 11 are overlap with the Higher Tier paper and so at Foundation Level it would not be surprising if candidates had struggled to access the questions. This however did not seem to be the case as many candidates attempted all parts of both questions.

In Q10(a)(i) ideas about organic formulae and structures were being assessed. The concept of Empirical formula often caught out candidates at this level, and very few gained any marks here. However, where they did gain marks was in correctly giving the molecular formula for hexane and then drawing the structure, the only common error here was in missing out the single bonds between the carbon atoms. Most candidates did attempt this part of (a)(i) and weaker responses often gave C_3H_7 as their formula for hexane and then drew a diagram showing 3 carbon atoms and 7 hydrogen atoms. Q10(a)(ii) was generally well done by candidates on the Foundation paper with many gaining both marks.

Question 10 (b) (i) and (b) (ii)

(b) (i) Predict the **boiling point** of hexane.

Use the data in **Table 10.1** to help you.

Boiling point = ... °C **[1]**

(ii) Explain why it is difficult to use the data in **Table 10.1** to predict the **melting point** of butane.

....

....

.... **[1]**

This pair of questions proved particularly challenging to students at this level. Candidates struggled with the concept of negative numbers and do not appreciate their magnitude or what they physically mean for the state of a substance. So, the boiling point of hexane was often quoted at a value just above that of pentane at about 50°C and the melting point of butane was left blank. For hexane, the answers were understandable as they knew that it should be higher than pentane, but they had not always looked at the data for other compounds to see if there was a pattern that could be extended.

For butane, however, most stated that the melting point could not be identified as it did not have a boiling point so a pattern could not be compared. This clearly identifies that students did not understand that 0°C could be a temperature where a substance boils and changes state from a liquid to a gas.

Question 10 (b) (iii)

(iii) What is the state of pentane at 25 °C?

Explain your answer.

State: ....

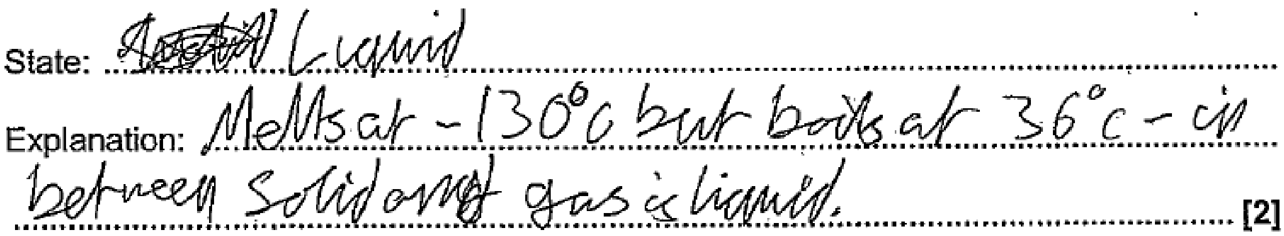
Explanation: ....

.... **[2]**

There were a varied set of responses to this question. All three states of matter were suggested and so solids or gases resulted in no marks being gained as often the reason given was incorrect. Where the correct state had been identified, i.e. liquid, the explanation was often incomplete, e.g. it is above its melting point with no reference to the boiling point, or, it has not yet reached its boiling point with no reference to the melting point. To gain the second mark here candidates had to make it clear that 25°C is **between** the melting point and boiling point of pentane.

Exemplar 8 illustrates a response from a candidate who has correctly identified the physical state for pentane at 25°C, and gives a description that implies that this temperature is between (key word from the mark scheme) the melting point of -130°C and the boiling point of (+)36°C, and so gained 2 marks.

Exemplar 8


State: Liquid
Explanation: Melts at -130°c but boils at 36°c - in between solid and gas is liquid. **[2]**

Question 10 (b) (iv)

(iv) Explain the trend in boiling points in **Table 10.1**.

Use ideas about energy and intermolecular forces in your answer.

....

....

....

.... **[2]**

Most candidates struggled to gain marks here. Answers were often incomplete, e.g. Boiling points get bigger usually linked to going down the table/group which was not deemed sufficient to be credited as there was no reference to the number of carbon atoms or size of the molecules increasing. Very few candidates attempted to link this to intermolecular forces, or they tried to do so but ended up with an answer that suggested they were breaking the covalent bonds between atoms within the molecules rather than overcoming the forces between molecules in the liquids. Exemplar 9 is a good exemplar of a correct response.

Exemplar 9

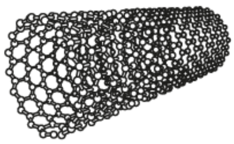
as the number of carbons increase, so does the boiling + melting point. intermolecular forces become stronger meaning you need much more energy to break those forces. **[2]**

Question 11 (a) (i), (a) (ii) and (a) (iii)

11 Carbon nanotubes were discovered in 1991.

Materials made from nanotubes can be used instead of steel because nanotubes are very strong. They are a few nanometres wide and up to 1 cm long.

The structure of a nanotube is shown below.



(a) (i) Nanotubes are nanoparticles.

Which statement explains why nanotubes are nanoparticles?

Tick (✓) **one** box.

They have covalent bonds.	☐
Their diameters are between 1 to 100 nm.	☐
They are made of carbon.	☐
They are hollow tubes.	☐

[1]

(ii) Which two statements explain why nanotubes are very strong?

Tick (✓) **two** boxes.

Bonds between carbon atoms are strong. ☐

Lots of bonds must be broken to break the tube. ☐

The nanotubes have a hollow centre. ☐

They are very small. ☐

They have a large surface area. ☐

[2]

(iii) Nanotubes are a similar shape to a human hair but they are much smaller.

A human hair has a diameter of 0.001 mm.
A nanotube has a diameter of 2 nm and a length of 5 mm.

A scale model of a nanotube has the **same** diameter as a human hair.

What is the length of the scale model in mm?

1 nm = 1×10^{-6} mm

Length = ... mm **[3]**

Q11(a)(i) and (ii) were questions where candidates often gained at least 1 mark if not 2. They were able to identify why they are termed nanoparticles in (a)(i) and often also correctly identified that the bonds between carbon atoms within the nanotubes are strong in (ii). However, very few attempted part (iii) as the calculation proved quite challenging. Those who did attempt it often struggled to convert from nm to mm or vice-versa and then multiplied values when they should have been dividing, but it was pleasing to see that more able candidates were willing to have a go at this question.

Question 11 (b)

(b) Short nanotubes can also be used to carry medicines into the body.

The medicine is put inside the tube and the tube is injected into the body.

Give **one** benefit and **one** risk of using nanotubes to carry medicines into the body.

Benefit

....

....

Risk

....

.... **[2]**

Responses here tended to be vague and generalised and could have been applied to any medical procedure rather than the ideas proposed in the question. Candidates gained marks for identifying that long-term effects, or side effects were not known as a risk for using nanotubes.

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