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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/02 Summer 2022 series

Version 1

ocr.org.uk/science

Contents

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers 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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

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Paper 2 series overview

J260/02 is one of the eight examination units for the GCSE 9 - 1 level examination for GCSE Combined Science. This component 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.

When looking at how students coped in the first examination series after two disrupted years of education it was very pleasing to note that most candidates had adequate time to attempt all of the questions. There is some evidence to suggest that some areas of practical work were able to be completed with restricted facilities, e.g. chromatography, which is tested in Question 5, could be carried out as a practical procedure in a classroom. However, neutralisation reactions which are tested in Question 3 and would normally require access to a laboratory, may not have been able to be completed due to some lessons being taught in classrooms as part of the restrictions imposed by Covid-19 'bubbles' in centres.

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. It was very pleasing to see that many candidates at foundation level not only attempted to answer these questions, but they often gained full marks for some parts of them.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• use ideas about the energy changes in chemistry in Question 1 (b) and Question 1 (d) • demonstrate knowledge and understanding relating to practical techniques, Question 3 (c), Question 5 (a) and Question 5 (b) • produced a clear and concise answer to the Level of Response question, Question 5 (c) • performed standard calculations showing clear working, and where appropriate conversion to the required number of significant figures, Question 1 (d), Questions 3 (e) (i), 3 (e) (ii) and Question 5 (b) • interpret data and draw conclusions, Question 1 (b) (ii), Question 2 (a), and Question 6 (a) (i).	• struggled to describe the steps displayed in an enthalpy profile, Question 1 (b) • found it difficult to apply their knowledge linking ideas about the periodic table to electronic structure in atoms and ions, Questions 4 (c) (i) and 4 (c) (ii) • often did not attempt questions addressing mathematical skills • did not balance chemical equations or to identify species within an equation Question 2 (c) and Question 3 (a) (i).

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

1 Cold packs are used to treat some sports injuries.

They contain ammonium nitrate and water.

(a) The formula of ammonium nitrate is NH_4NO_3.

(i) Name the **three** elements present in ammonium nitrate.

1 ....

2 ....

3 ....

[3]

(ii) What is the total number of atoms shown in the formula?

.... **[1]**

Most candidates gained at least 2 marks in Question 1 (a) (i) as they identified both oxygen and hydrogen correctly, the vast majority also recognised nitrogen although a significant number of candidates did give an incorrect identification of nitrate or ammonium here. In Question 1 (a) (ii), many candidates gained this mark as they correctly stated that there are 9 atoms contained within the formula given, the most commonly seen incorrect response here was 7 atoms.

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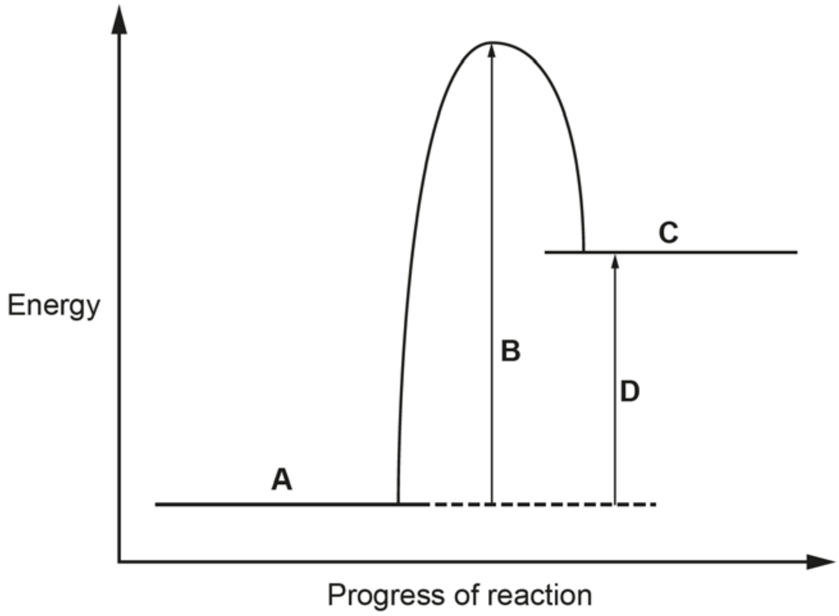
Question 1 (b) (i) and (ii)

(b) When the ammonium nitrate and water mix in the cold pack, the temperature of the mix decreases.

The diagram shows the reaction profile for this reaction.



(i) What is the name given to a change which makes the temperature of the mix decrease?

Put a ring around the correct option.

Combustion **Endothermic** **Exothermic** **Freezing**

[1]

(ii) Draw lines to connect each **label** with its correct **position** on the diagram.

Label	Position
Activation energy	**A**
Energy of reaction	**B**
Products	**C**
Reactants	**D**

[3]

This pair of questions proved challenging to many candidates. In Question 1 (b) (i), the expected answer was 'endothermic' which was correctly identified in the more successful responses, with 'freezing' being the most commonly circled response. This probably came from the information provided about ice packs in the stem of the question, rather than candidates using their chemistry knowledge. In Question 1 (b) (ii), candidates were asked to identify the relevant features of the enthalpy profile by drawing links between the correct label and its position on the diagram. The more successful responses did this well, often gaining full marks, but less successful responses struggled and often gained only 1 or 2 marks. They often mixed up the two energetic steps by reversing the links between them, i.e. 'activation energy' was linked to D and 'energy of reaction' linked to B rather than vice versa.

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Question 1 (c) and (d)

(c) Kofi plans an experiment to find the energy change when the ammonium nitrate from a cold pack dissolves in water.

The energy change depends on the mass of water and the temperature change.

What apparatus will he need to take the measurements?

Tick (✓) **two** boxes.

Balance	☐
Burette	☐
Gas syringe	☐
pH meter	☐
Pipette	☐
Thermometer	☐

[2]

(d) Here are Kofi's results.

Mass of water used = 250 g	
Temperature of water before adding ammonium nitrate	= 20.2 °C
Temperature of water after adding ammonium nitrate	= 4.8 °C

Calculate the energy change when the ammonium nitrate from the cold pack dissolves in water.

Use the formula: Energy change (J) = 4.2 × mass of water (g) × temperature change (°C)

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

Energy change = ... J **[3]**

Question 1 (c) was the first question relating to practical work and asked candidates to choose the two pieces of apparatus that would be required to take the measurements needed. Candidates were told to tick (√) two boxes. Despite the key word being in bold many candidates still only ticked one box and so did not give themselves the chance to gain full marks in this question. Those who did follow the instructions often chose the thermometer correctly as the piece of apparatus required to measure temperature, but did not choose the balance as being the piece of apparatus needed to measure the mass of water. Question 1 (d) presented the candidates with a set of results for the experiment and asked them to calculate a value for the energy change in the reaction, giving their final answer to 3 significant figures.

OCR support

Our Summer Highlights report is a great resource to print for candidates or display in classrooms to train them to avoid these common mistakes, such as not selecting the correct number of options or giving their answers to the correct number of significant figures. They are also available to print in A3 size.

Exemplar 1

Energy change = 4.2 × ~~250g~~ 250g × 15.4°C = 16170J

20.2 − 4.8 = 15.4°C

= 16 J

Energy change = 16 J **[3]**

Exemplar 1 shows a typical response to this question where the candidate correctly calculated the temperature change and inserted it into the formula provided and evaluated the formula correctly. As with many candidates at this level the final step in this exemplar was typical of the responses that did not gain the final mark.

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

2 Harmful gases such as NO, CO and SO_2 are emitted from car engines running on fossil fuels.

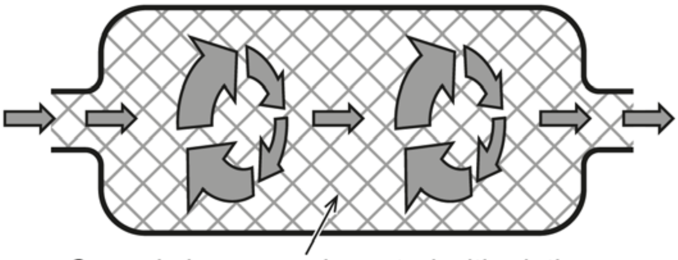
(a) These gases are produced in the car engine.

Draw lines to connect each **gas** with its **formula** and **how it is formed**.

Gas	Formula	How it is formed
Sulfur dioxide	CO	Combustion of sulfur impurities in the fuel
Carbon monoxide	NO	From air at high temperature
Nitrogen monoxide	SO_2	Incomplete combustion of the fuel

[4]

(b) Some harmful gases are removed by a catalytic converter before leaving the exhaust pipe of the car. The diagram shows gases passing through a catalytic converter coated with a catalyst.



The harmful gases from the car engine do not react with each other until they are in contact with the hot catalyst.

(i) Why do the gases not react with each other until they are in contact with the hot catalyst?

Tick (✓) **one** box.

The reaction has a high activation energy.	☐
The reaction is exothermic.	☐
The reaction is too fast.	☐
The catalyst is used up in the reaction.	☐

[1]

(ii) Suggest why the catalyst is coated on a ceramic honeycomb.

....

.... **[1]**

This set of three questions were structured in a way to determine how much candidates understood about pollutants from fossil fuels and how these are controlled in car exhaust systems. Question 2 (a) was generally well answered and most candidates gained 3 marks as they could successfully link the gas with its chemical formula and then either linked sulfur dioxide to the combustion of sulfur impurities in the fuel, or linked carbon monoxide to incomplete combustion of the fuel. The most common error evident here was usually mixing up carbon monoxide and nitrogen monoxide to the method of formation for each gas. Question 2 (b) (i) was one of the best answered questions on the paper as nearly every candidate knew that catalysts were used because the reaction has a high activation energy (box 1). In contrast very few candidates recognised that the reason for using a honeycomb was to increase the surface area, or to reduce the amount of metal required, and so a range of incorrect responses was evident in Question 2 (b) (ii).

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Question 2 (c)

(c) The equation shows one reaction of the gases in the catalytic converter.

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

Identify which gas is oxidised.

Explain your answer.

Gas which is oxidised ....

Explanation ....

....

.... **[2]**

This question proved a challenge to many candidates. Most recognised that CO_2 was the oxidation product but identified this as the gas that had been oxidised rather than carbon monoxide, and explanations usually included the idea that this was because it had the most oxygen in its molecule. What was evident in candidates' responses was that they had a basic understanding of what happens during an oxidation reaction but struggled to express themselves in an appropriate manner.

Assessment for learning

From this question it is apparent that candidates would benefit from spending time looking at a range of oxidation (and reduction) equations and practising describing in words what is happening in each equation, in terms of gaining or losing oxygen.

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Question 3 (a) (i) and (ii)

3 Magnesium hydroxide reacts with hydrochloric acid in a neutralisation reaction.

(a) (i) Complete the balanced symbol equation for the reaction between magnesium hydroxide and hydrochloric acid.

$Mg(OH)_2$ + ...$HCl \rightarrow MgCl_2$ + ...H_2O **[1]**

(ii) Draw lines to connect each **compound** from the reaction with its correct **description**.

Compound	Description
HCl	Acid
H_2O	Alkali
$MgCl_2$	Salt
$Mg(OH)_2$	Water

[3]

Question 3 (a) (i) is a good discriminator for this paper as only the most successful responses were able to balance the equation. Less successful responses attempted to balance it but typically only put a 2 in front of the formula for hydrochloric acid, HCl. A number of candidates omitted this question altogether. Question 3 (a) (ii) was designed to find out if candidates could recognise the chemical species present in the neutralisation reaction. Most candidates gained 1 mark for correctly identifying water with its formula. There were however a significant number of candidates for whom this was the only mark gained in this question.

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Question 3 (b) and (c)

(b) Complete the sentence about neutralisation.

Use the symbols and words from the list.

acid	**alkali**	**water**	Cl^-	H^+	Mg^{2+}	OH^-

Neutralisation occurs when .... ions from an

.... react with .... ions from an

.... to form ....

[3]

(c) Milk of magnesia is a medicine used to neutralise excess acid in the stomach.

Milk of Magnesia
One 15 cm^3 spoonful contains 1200 mg of magnesium hydroxide.

Leo does a titration with hydrochloric acid to check the amount of magnesium hydroxide in one spoonful of Milk of Magnesia.

This is the method:

- Add 15 cm^3 of Milk of Magnesia into a conical flask
- Add a few drops of indicator
- Add hydrochloric acid from a measuring cylinder until all of the magnesium hydroxide is neutralised.

When should Leo stop adding the acid?

Tick (✓) **one** box.

When all the acid has been added. ☐

When he has added 15 cm^3 of acid. ☐

When the conical flask is full. ☐

When the indicator changes colour. ☐

[1]

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More successful responses answered this question well and gained 3 marks. Many candidates only gained 1 mark as they recognised that a product of a neutralisation reaction was water. The most common errors seen were in mixing up the H^+ ion and OH^- ions with the acid or alkali which unfortunately lost candidates marks as the mark scheme was very definitive on selecting the correct ions. In Question 3 (c) most candidates correctly stated that Leo should stop adding the acid 'When the indicator changes colour' (box 4) and gained this mark.

Question 3 would normally have been a question that most candidates would have had the opportunity to experience the practical work for themselves, which always improves candidates understanding of a process. But, due to the disruption created by Covid-19, some centres may not have had the opportunity for candidates to do this work for themselves which may explain why there was such a variety of responses evident.

Neutralisation Reactions

Teachers are advised to reinforce learning in topic C6 Making useful chemicals with extended practice on writing word equations, and expose candidates to as many different examples as possible. In addition to looking at the general equation for a neutralisation reaction, candidates require help in identifying the key ions involved in acid-alkali neutralisation reactions.

OCR support

A very useful resource to support candidates with retrieval and misconception identification can be found in our Twenty First Century Science Quizzes (available to download with your interchange login).

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Question 3 (d)

(d) Leo decides to measure the acid with a more accurate piece of apparatus instead of the measuring cylinder.

Which piece of apparatus should he use?

Put a ring around the correct answer.

Beaker **Burette** **Flask** **Thermometer**

[1]

Question 3 (d) asked candidates to identify a more accurate piece of equipment to use to measure out a volume of acid, with the expected response being to choose the burette. Many candidates did this but many were not given this mark as they chose the beaker from the list.

Question 3 (e) (i)

(e) Leo repeats the titration with the more accurate piece of apparatus.

Here are his results.

	1	**2**	**3**	**4**	**5**
Volume of acid used (cm^3)	29.30	27.20	27.30	27.20	27.30

(i) Calculate the mean volume of acid used.

Mean volume of acid used = ... cm^3 **[2]**

Question 3 (e) was designed to test candidates' maths skills within chemistry. In Question 3 (e) (i), the correct process should have seen candidates omitting result 1, 29.30cm^3, and then adding up the remaining 4 values to calculate the mean volume used. The most successful candidates did this and gained both marks for this question, but more pleasing was that the vast majority of the cohort engaged with the question and calculated a mean value from all 5 results that was rewarded with a mark.

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Question 3 (e) (ii)

(ii) The label says that there is 1200 mg of magnesium hydroxide in one 15 cm^3 spoonful.

Calculate the volume of hydrochloric acid needed to react with the magnesium hydroxide in the spoonful.

Use the formula:

Mass of magnesium hydroxide(g) = volume of hydrochloric acid(cm^3) × 0.044

Volume of hydrochloric acid = ... cm^3 **[3]**

In Question 3 (e) (ii), there was a calculation where candidates had to use their maths skills to first of all convert 1200mg into g (divide by 1000) and then to rearrange the formula given to make the volume of acid the subject of the equation. Pleasingly many candidates attempted this question. Most were able to gain some marks for their endeavours. Where candidates did successfully rearrange the formula this would normally gain 1 mark, the second mark was often not scored as having re-arranged the formula they then used 1200 in the calculation and divided this by 0.044. If they evaluated this expression correctly to 27272.72… this gained a second mark.

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Question 4 (a) and (b)

4 Sodium is a metal and oxygen is a non-metal.

(a) Complete the table to describe the difference in the properties of metals and non-metals.

Use words from the list.

dull	**high**	**low**	**shiny**

Property	**Metals**	**Non-metals**
Melting point	high	low
Boiling point	....	....
Density	....	....
Appearance	....	....
Electrical conductivity	good	none

[3]

(b) Complete the sentence to explain why sodium is a good conductor of electricity.

Put a ring around the **two** correct answers.

Sodium is a good conductor of electricity because it has **electrons / ions / molecules** which are **fixed / mobile / static**. **[2]**

Question 4 assessed candidates' knowledge and understanding about metals and non-metals. Parts (a) and (b) tested ideas about physical properties. Most candidates correctly identified that metals have high boiling points and density and are shiny, while non-metals have low boiling points and densities and have a dull appearance and gained 3 marks in part (a). However in part (b) the increase in choices available to candidates produced a raft of combinations, such that, only the more successful candidates gained both marks here, and only the least successful of candidates did not gain any marks.

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Question 4 (c) (i)

(c) Sodium has an electronic structure 2.8.1 and oxygen has an electronic structure 2.6.

(i) Complete the table to show the position of these two elements in the Periodic Table.

Use the Data Sheet.

	Period	**Group**
Sodium	....	....
Oxygen	....	....

[2]

Evidence from the scripts suggests that despite being told to use the data sheet many candidates were unable to identify the correct group/period in Question 4 (c) (i). However, if they identified that sodium was in group 1 and oxygen in group 6(16) then they gained a mark for this combination, this proved beneficial to many candidates who did not identify the period these elements were in on the periodic table but could pick out the group number.

Question 4 (c) (ii)

(ii) Sodium and oxygen react together to form sodium oxide.

Complete the table to show the electronic structures and charges of the ions formed.

	Electronic structure	**Charge**
Sodium ion	....	....
Oxide ion	....	....

[3]

In Question 4 (c) (ii), very few candidates attempted to give the electronic structure for the ions, many did give the correct configuration for a sodium ion, but were unable to do the same for the oxide ion. A common incorrect answer here was 2.7, presumably from assuming that the electron lost by the formation of the sodium ion was then gained by the oxygen atom. This was a hard mark for candidates to gain as they needed to give both electronic configurations correctly for 1 mark. However, this was compensated for as 2 marks were possible from stating what the charge was on each of the ions. For sodium the possibilities were +1/1+ or '+' on its own. We did not allow the word positive on its own without the number 1 being present. Similarly for the oxide ion we allowed -2 or 2- but not negative on its own as the ion has a double negative charge so there has to be some indication of the magnitude of the charge if it is to be described. The least successful responses omitted this question.

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Question 5 (a)

5 Paper chromatography can be used to identify dyes in a mixture.

(a) Complete the sentence to describe how chromatography works.

Use words from the list.

condensed	**distributed**	**dyes**	**mobile**	**paper**	**solvent**	**stationary**

The .... in the mixture are separated when they are

.... between the .... which is the

.... phase and the .... which is the

.... phase.

[4]

Question 5 tested candidates' comprehension and communication skills across all parts of the question.

In part (a) there were 4 marks available. The first 2 marks were relatively easy to gain and many candidates did this successfully. There were very few scripts evident where candidates did not attempt this question, and many candidates did gain the first 2 marks. The second pair of marks were more difficult to achieve, as they not only assessed candidates' knowledge about the process of chromatography but also their ability to reason and communicate their understanding effectively. Each mark could only be gained by identifying a pair of linked responses. These were, the **paper** with the **stationary phase**, and the **solvent** with the **mobile phase**.

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Question 5 (b)

(b) Rf values are used to identify dyes. They are calculated using this equation:

$$Rf = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent}}$$

The Rf value of a dye can be calculated from the result of an experiment and compared with Rf values in a data book.

Table 5.1 shows the results of an experiment to identify an unknown dye.

Table 5.2 shows the Rf values of some dyes in a data book.

Distance moved by the dye (cm)	3.5
Distance moved by the solvent (cm)	8.3

Table 5.1

	Rf value
Marigold Orange	0.36
Mustard Yellow	0.89
Sunshine Yellow	0.42

Table 5.2

Which dye has been identified from the experimental results in **Table 5.1**?

Use a calculation to explain your answer.

....

....

....

....

....

.... **[3]**

A very good majority of candidates gained all 3 marks for Question 5 (b), with a smaller number able to score at least 1 or 2 marks. Most candidates used the equation provided in the stem of the question along with the values quoted in Table 5.1 to calculate the Rf value for the unknown dye. Provided that they had displayed their working and evaluated this correctly they gained 2 marks. Having done this they then had to use the values from Table 5.2 to identify the correct dye which many also did to gain a third mark.

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Question 5 (c)*

(c)* A student checks the Rf value of sunshine yellow using chromatography.

The chromatogram produced by the student is shown for the sunshine yellow dye.

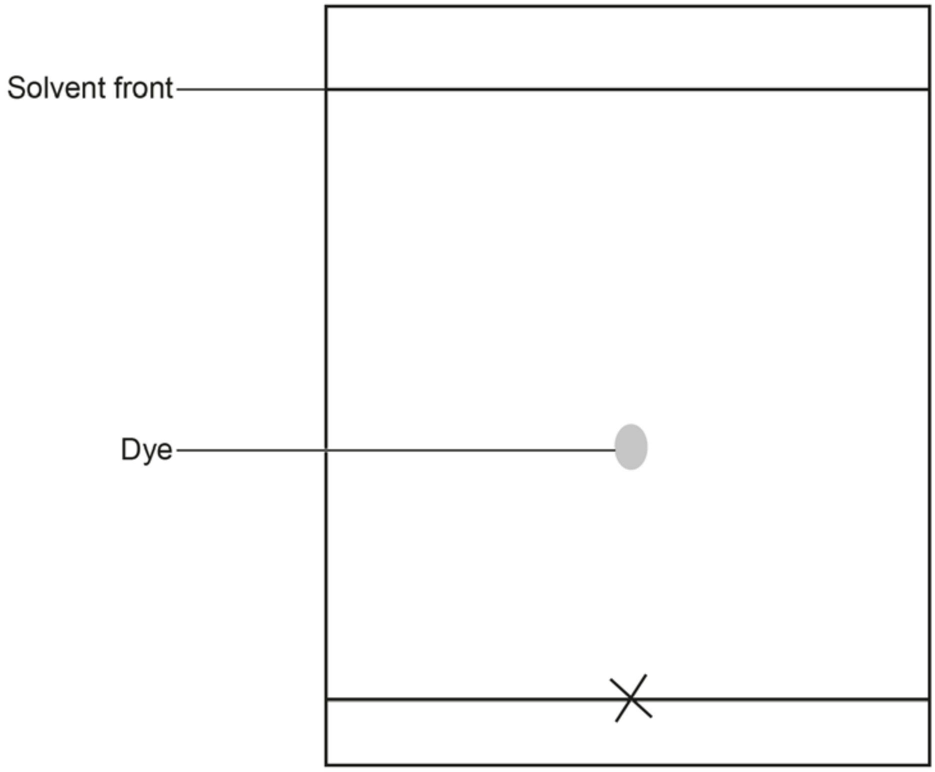

Fig. 5.1

Describe how the student did the experiment to find the Rf value of the dye.

Include the apparatus used and any measurements taken.

....

....

....

....

....

.... **[6]**

Question 5 (c) was the Level of Response question for this paper. Examiners are instructed to read through the whole of the response and to assign a mark to each one depending on how well candidates have matched to the level descriptors in the mark scheme. Within each descriptor there is a science statement and a communication statement that is common to all Level of Response questions within the suite of papers making up this qualification. Examiners are directed to assess the level of the science in the answer provided and then to assess the level of communication skills utilised. Only if both statements are satisfied can the upper mark in a level be given, the science content determines the appropriate level with the communication statement determining the mark within the level.

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The two exemplars chosen here show responses at Level 2 and 3.

To gain marks here the candidates needed to state what apparatus they would require to carry out the practical. They also needed to explain how they would use the apparatus and at the higher levels include some fine detail about some of the steps in their procedure. Finally they should clearly state what measurements they needed to make and ideally how they would make these measurements. There were no marks given for quoting the equation for calculating the Rf value as this was given to them on page 14 of the exam paper.

OCR support

Our [Practical skills Extensions booklet] has extra questions to use with candidates so that they can apply and extend their understanding of the practical activity groups.

Exemplar 2

The student placed a drop of a sample of dye on ~~&~~ litmus paper. They drew a line at the bottom of the paper using a pencil. Using a pen ~~Wt~~ would affect the experiment as the ink from the pen would start to move. The dye moved up the ~~At~~ paper revealing whatever colour it was. The solvent front is where the solvent stopped at. The litmus paper is placed in water to let the dye move up. The student measured from the middle of the dye and where the solvent front went up to. They calculated ~~&~~ the distanced of the dye divided by the distance of solvent front to get the Rf value. **[6]**

Exemplar 2 gives a basic method but includes some good fine detail and implies the measurements that are required to calculate the Rf value for the dye. The use of litmus paper has been seen on a number of scripts and was not deemed to be detrimental to the procedure so this was not penalised and a mark of 4 was given. To move to Level 3 the candidate would have needed to include extra pieces of fine detail and explain how they would make their measurements.

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Exemplar 3

Firstly the student will have drawn a line in pencil near the bottom of the chromato-graphy paper then they will have put a spot of dye on the line. Then put the paper in a beaker with a solvent, solvent not reaching the line then put a lid and leave. once completed it would be left to dry. To calculate the Rf value they would have measured with a ruler the distance the ~~subs~~ dye travelled and the distance the solvent travelled. Then divided the numbers to calculate the Rf value. **[6]**

Exemplar 3 gives a detailed method that is logical and structured, and includes the use of a ruler to measure the distances travelled by both the dye and the solvent. The response includes a number of pieces of fine detail that are identified in the guidance column of the mark scheme, and it is worth noting that to achieve Level 3 it was not necessary to include all of these points. The response fully matches to the Level 3 descriptor in the left hand column of the mark scheme in both its science content and the communication of ideas, and was given 6 marks.

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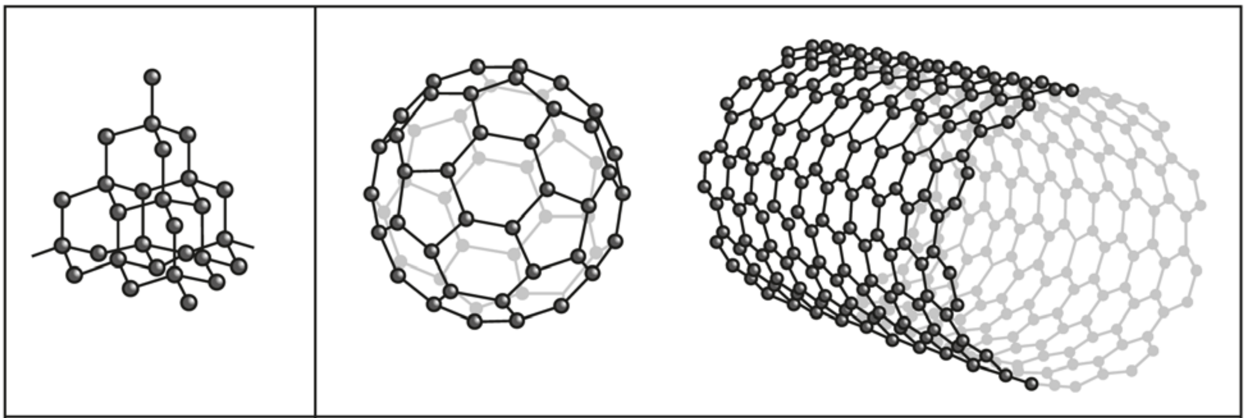
Question 6 (a) (i) and (ii)

6 The diagrams show the structures of some forms of carbon.



Diamond	**Fullerenes**

(a) (i) How do the diagrams show that all the structures are the same element?

Tick (✓) **one** box.

There is only one type of atom in all of the structures. ☐

They are all the same shape. ☐

They are all 3 dimensional. ☐

They all have the same number of atoms. ☐

[1]

(ii) Which statements about these structures are **true only for diamond**, which are **true only for fullerenes**, and which are **true for all the structures**?

Tick (✓) **one** box in each row.

	True only for diamond	**True only for fullerenes**	**True for all the structures**
Each carbon atom is bonded to 3 others.			
All atoms are held together by covalent bonds.			
Carbon atoms are arranged in a tetrahedral (pyramidal) shape.			

[3]

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Question 6 was in two distinct but linked sections dealing with allotropes of carbon, and the application of fullerenes in nanotechnology.

Questions 6 (a) (i) and (ii) looked to ascertain candidates' knowledge about the allotropes and in Question 6 (a) (i) most candidates correctly chose option 1 as their answer. The most common incorrect response here was to see candidates choose option 3, 'they are all 3 dimensional'.

In Question 6 (a) (ii) candidates were asked to use the images contained in the stem of the question to make decisions about diamond and fullerenes, with most candidates gaining at least 2 marks here for identifying that all atoms in the structures are held together by covalent bonds, and that in diamonds the atoms are arranged in a tetrahedral shape.

OCR support

These multiple choice questions can be used to check knowledge is secure or for regular retrieval practice. A login for interchange is required to download these resources.

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Question 6 (b) (i), (ii) and (iii)

(b) Fullerenes are nanoparticles.

(i) What is the approximate size of a nanoparticle?

Put a ring around the correct answer.

≤100 nm **1000 nm** **10 000 nm** **≥10 000 nm**

[1]

(ii) Fullerenes can be used to carry drugs into the body.

Which **two** statements explain why?

Tick (✓) **two** boxes.

They are small enough to pass through body tissues.	☐
They are made of carbon atoms.	☐
They can fit molecules inside them.	☐
They are good for you.	☐
They can act as catalysts.	☐

[2]

(iii) Some people do not agree with the use of nanoparticles to carry drugs into the human body. Others think that the benefits outweigh the risks.

Suggest **one** risk and **one** benefit to a person's health of using fullerenes to carry drugs into the body.

Risk ....

....

Benefit ....

....

[2]

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Question 6 (b) was challenging for most candidates. Very few candidates realised that nanoparticles are very small (i.e. $\leq$ 100nm) and so very few candidates gained a mark in (b) (i). However, they did recognise that if they are to be used to carry drugs into the body that they need to be small enough to pass through body tissues (box 1 of (b) (ii)) to gain 1 mark, and more successful responses also suggested that they were small enough to fit molecules inside them (box 3 of (b) (ii)). The most commonly seen incorrect response chosen here was option 5 'they can act as catalysts'.

In Question 6 (b) (iii), candidates struggled to gain more than 1 mark. They quite often gained a mark for identifying that the main risk from nanoparticles was that they are a relatively new technology and that as such the side effects are unknown, not fully understood or that the long-term effects have not been determined. There were other alternative responses that were creditworthy such as they may cause cancer if absorbed into the wrong tissue/organ. Candidates did struggle with identifying a benefit of nanoparticles and often simply quoted statements from Question 6 (b) (ii), or restated that they could carry drugs into the body, neither of these options were given marks.

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Question 7 (a) (i), (ii) and (iii)

7 **Table 7.1** shows some information about the elements in Group 17(7) of the Periodic Table.

	State and colour at 20 °C	Reaction with iron wool	Product
Fluorine	pale yellow gas	Reacts instantly.	Iron fluoride
Chlorine	yellow-green gas	Reacts with heated iron wool very quickly, although not as quickly as fluorine does.	Iron chloride
Bromine	deep red liquid	Has to be warmed and the iron wool heated. The reaction is faster than that of iodine but slower than that of chlorine.	Iron bromide
Iodine	grey solid	Has to be heated strongly and so does the iron wool. The reaction is slow.	Iron iodide

Table 7.1

(a) **(i)** Name the most reactive member of Group 17(7).

.... **[1]**

(ii) Name **one** member of Group 17(7) that is not shown in **Table 7.1**.

.... **[1]**

(iii) Predict the state and colour at 20 °C, the reaction with iron wool and the product of the reaction for the element identified in **(ii)**.

State and colour at 20 °C ....

Reaction with iron wool ....

....

Product formed with iron wool ....
[3]

Question 7 (a) was about identifying trends in group 7 of the periodic table, and many candidates gained 2 or more marks across this question. In (a) (i), the correct answer, fluorine, was usually correctly identified by candidates. The only commonly seen incorrect response was iodine. In (a) (ii), astatine was often correctly identified again by the majority of candidates. There were very few scripts where these two questions were not attempted.

In (a) (iii), candidates were asked to extrapolate from the information provided in Table 7.1 to predict the properties of a compound of astatine. Many candidates suggested that the colour would be dark grey or black but did not identify it as a solid so did not gain a mark here that should have been achieved had they read the question carefully. For the reaction with iron wool, again there were lots of answers where the candidate recognised that the reaction would be slow, but to gain a mark they had to continue the trend from the table and state that it would be very slow, or that it would need to be heated very strongly.

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These emboldened words were essential in order to differentiate the reaction with astatine from the reaction with iodine. Although candidates struggled with the first two sections of this question they often did gain a mark for naming the product of the reaction as iron astat**ide -** although minor mis-spellings were accepted provided it did not look like astat**ine.**

Question 7 (b) (i) and (ii)

(b) The elements in Group 17(7) form compounds with other metals.

Table 7.2 shows information about some of these compounds.

Ions	Formula	Relative formula mass
....	KF	58.1
Ca^{2+} and Br^{-}	....	199.9
Fe^{3+} and F^{-}	FeF_3	

Table 7.2

(i) Complete the table to show the missing ions and formula. **[2]**

(ii) Calculate the relative formula mass for FeF_3.

Use the Data Sheet.

Relative formula mass = ... **[2]**

Question 7 (b) was about using the periodic table to make predictions about ions, formulae and using atomic masses to calculate a formula mass. Less confident candidates found this most challenging and as a result there were often gaps left on some scripts.

In Question 7 (b) (i), candidates often gave the correct symbol for the potassium ion, but gave an incorrect charge, or magnitude of the charge when describing the fluoride ion even though it was already present in the formula for iron(III) fluoride in Table 7.2. Many candidates also did not spot the pattern in the formulae in column 2 and did not give the correct formula for calcium bromide. So, many candidates did not gain any marks here.

In Question 7 (b) (ii) if candidates correctly identified the relative atomic mass values for both iron (55.8) and fluorine (19) and made use of these in an attempted calculation for the relative formula mass of Iron(iii) fluoride then a mark was given even if the total was not 112.8. The most commonly seen response that gained a mark was 74.8, but only if supported by clear evidence of using 55.8 and 19.

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

8 The table gives information about some of the compounds present in crude oil.

Number of carbon atoms	Molecular formula	Empirical formula	Melting point (°C)	Boiling point (°C)	State at room temperature
4	C_4H_{10}	C_2H_5	–138	0	Gas
5	....	C_5H_{12}	–130	36	
6	C_6H_{14}	C_3H_7	–95	69	Liquid
7	C_7H_{16}	C_7H_{16}	–90		Liquid
8	C_8H_{18}	....	–57	126	Liquid

(a) (i) Complete the table to show the missing molecular formula and empirical formula. **[2]**

(ii) Predict the boiling point for the compound with 7 carbon atoms.

Boiling point = ... °C **[1]**

Questions 8 and 9 were the final two questions on the foundation paper and are common with the higher tier paper. It was very pleasing to see that many candidates at foundation level not only attempted to answer these questions, but they often gained full marks for some of them.

Typically Question 8 (a) (i) reflected this. Many candidates attempted this question and most of those who did so were given at least 1 mark, often for correctly stating the empirical formula for octane, C_4H_9,. They also tried to determine the molecular formula for pentane and gave the correct number of carbon atoms but an incorrect number of hydrogen atoms.

Question 8 (a) (ii) then asked candidates to make a prediction for the boiling point of C_7H_{16}, and a significant number realised that it should have been approximately halfway between the values for C_6H_{14} and C_8H_{18} and gave a figure within the range 90°C to 102°C to gain another mark.

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Question 8 (a) (iii)

(iii) Predict the state of the 5 carbon compound at room temperature (20 °C).

Explain your answer.

State ....

Explanation ....

....

.... **[2]**

This question was found to be a good discriminator for the highest achieving candidates. A good proportion often correctly identified that the compound should be a liquid and were able to explain why this was the case. While others could often correctly state that the compound is a liquid but their explanations were lacking in detail as they only compared the physical state against one of the fixed point temperatures, usually the boiling point.

Question 8 (b) (i)

(b) All the compounds in the table are in the same homologous series.

All members of a homologous series have the same general formula.

(i) Give **two** other characteristics of a homologous series that are shown in the table.

1 ....

....

2 ....

.... **[2]**

This question proved to be very challenging to candidates on this paper. The less successful candidates tended to leave this blank, while more confident candidates who did attempt it seldom gained any marks. Typical responses were trying to link the number of carbon atoms to either the melting point or the boiling point but it became apparent that many candidates struggled with the concept of negative numbers. The other common response was to suggest that as the number of carbons increased the substances became liquids, even though the smallest hydrocarbons in the table were clearly labelled as gases.

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Question 8 (b) (ii)

(ii) Complete the sentences to describe the compounds present in crude oil that are shown in the table.

Put a ring around each correct answer.

Crude oil is a mixture of **hydrocarbons / polymers / salts**.

The compounds are from the homologous series **allotropes / alkanes / alkenes**.

They all have the general formula $\mathbf{C_nH_{2n}}$ / $\mathbf{C_nH_{2n+1}}$ / $\mathbf{C_nH_{2n+2}}$.

[3]

In Question 8 (b) (ii), candidates often gained at least one mark for correctly stating that crude oil is a mixture of hydrocarbons. A wide variety of all of the other responses were chosen in the subsequent sentences, however, with no pattern emerging that could point to one particular misconception over another.

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Question 9 (a) (i), (ii) and (iii)

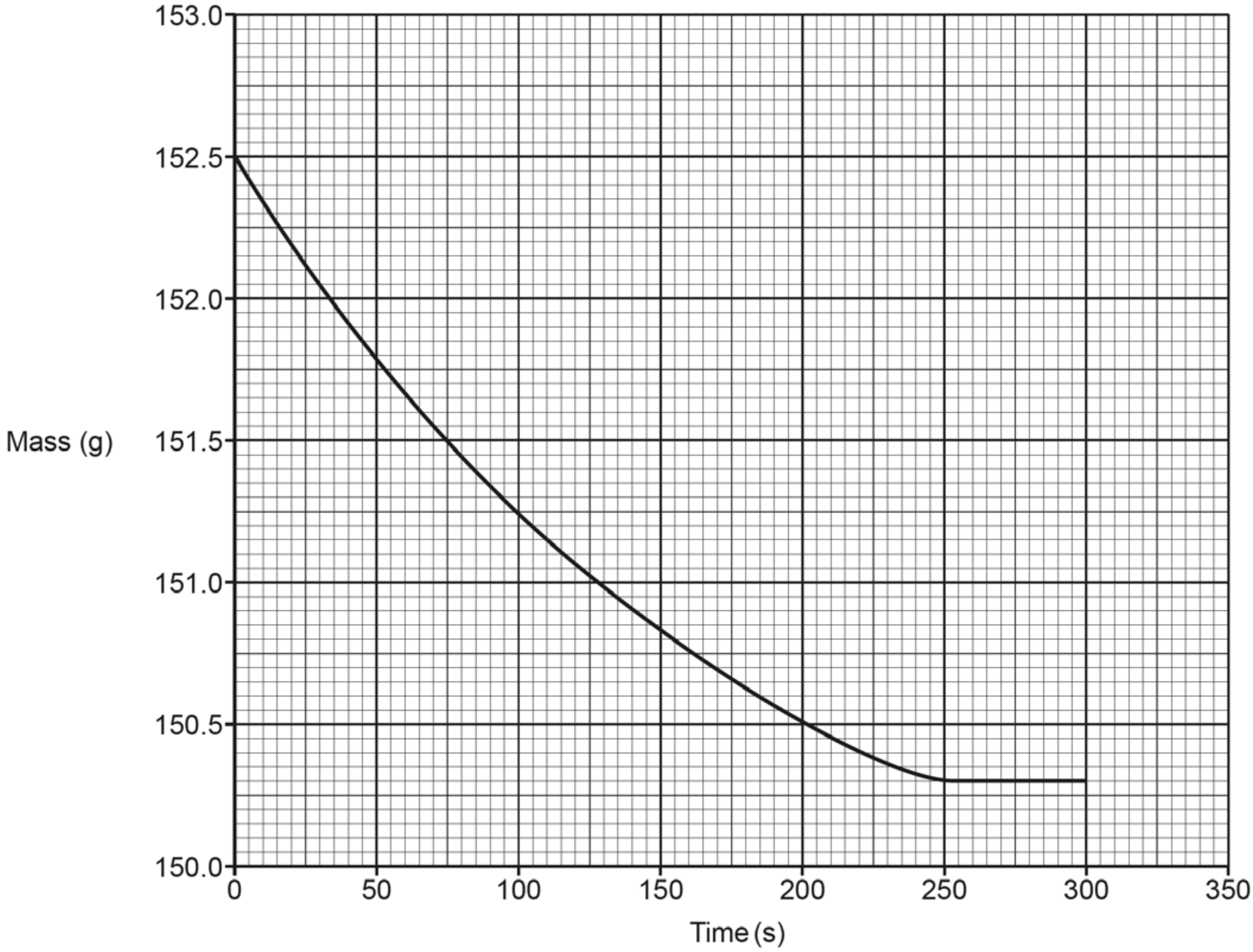
9 Solid calcium carbonate reacts with dilute hydrochloric acid to form calcium chloride, carbon dioxide and water.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) Jane investigates the rate of this reaction. She measures the change in mass during the reaction over five minutes.

She uses 10 g of calcium carbonate lumps and 50 cm^3 of dilute hydrochloric acid.

The graph shows Jane's results.



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

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

(ii) What was the total mass lost during the reaction?

Total mass lost = ... g **[2]**

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(iii) Calculate the average rate of the reaction.

Rate of reaction = ... g/s **[2]**

Question 9 used a graphical method to present the results from an experiment conducted to look at how calcium carbonate reacts with hydrochloric acid.

Question 9 (a) (i) asked candidates to state how long it took for the reaction to finish. Less successful candidates suggested that it took 300 seconds from looking at the graph to see where the curve ended rather than at 250 seconds where the curve became horizontal.

Question 9 (a) (ii) then asked candidates to determine the total mass lost during the experiment. At this tier, it was not uncommon to see incorrect values such as 150.0g, 150.25, or 2.5 being given. These arise from candidates reading the bottom value on the y-axis, candidates reading the value from where the line becomes horizontal, or from subtracting 150.0 from 152.5. Very few candidates correctly calculated the value as 2.2g.

Question 9 (a) (iii) was probably the most challenging question on this paper, and it was not uncommon to see the answer space left blank. Some candidates did attempt the calculation but struggled to gain any marks. More common errors saw candidates multiplying values from (a) (i) and (a) (ii), using a different value for the mass from their answer in Question 9 (a) (ii) above, or carrying out some other mathematical operation using their values.

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Question 9 (b)

(b) Jane repeats the experiment with 10 g of calcium carbonate **powder** instead of 10 g of lumps. She keeps everything else the same.

Sketch a line on the graph to show the results she should expect. **[2]**

Candidates struggled with this and it was not unusual to see the graph left blank. If they did try to draw a curve many drew it above the original curve which was not creditworthy. However, a good number of candidates who attempted this did draw a curve below the original curve that initially was steeper, but then did not gain a mark as their curve met the y-axis at an inappropriate value. They seldom recognised that the final mass should have been the same as in the original experiment and their curves often tended towards the x-axis.

Assessment for learning

Graph skills: candidates sitting the higher tier paper also found drawing an extra line on the graph challenging, along with interpreting the end of the reaction. Candidates should be provided with lots of opportunities to practice, not only drawing their own graphs, but reading and interpreting. Teachers might find this resource from our Gateway suite useful in planning lessons for candidates to improve their working scientifically skills.

Question 9 (c)

(c) Complete the sentences to explain why the rate of reaction changes when powdered calcium carbonate is used instead of lumps.

Put a ring around each correct answer.

The surface area of 10 g of powdered calcium carbonate is **larger than / smaller than / the same as** 10 g of lumps.

The total volume of 10 g of powdered calcium carbonate is **larger than / smaller than / the same as** 10 g of lumps.

[2]

The final question on the paper was attempted by a significant number of candidates and suggests that most candidates had adequate time to attempt all of the questions. In this question, candidates were asked to explain why the rate of reaction changes when a powder is used compared to the same mass of reactant as lumps. The options presented to the candidates were the same for each sentence and produced a variety of combinations, the most popular of which was to circle the first option in each sentence. This may have been guess work by the candidates towards the end of the allotted time for the paper, but if they chose this combination then they were rewarded by gaining a mark in the first sentence.

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