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 2018 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 J260/02 series overview

J260/02 is one of the eight examination components for the new revised 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.

Candidate performance overview

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

- Use ideas about the particle to explain what happens at a change of state, Q2b, 2c, and Q3b(ii) – 3b(iv)
- Demonstrate knowledge and understanding relating to practical techniques, Q4b and c, Q7b – d, Q8a – d(iv)
- Produced a clear and concise answer to the Level of Response question, Q6.
- Performed standard calculations showing clear working, and where appropriate conversion to the required number of significant figures, Q7e(i) and (ii), Q8d(iv) and Q10c(ii).

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, Q2c, 3b(ii) and 3b(iv)
- Found it difficult to apply their knowledge in novel situations.
- 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 **(a)** Mendeleev developed the first Periodic Table. He looked for patterns in the properties of elements.

He discovered that by putting the elements in order of their atomic mass he could group together elements with similar properties.

The properties of some of the elements did not fit into the pattern.

What did Mendeleev do to make the pattern of properties fit?

Tick (✓) **two** boxes.

He put the elements in alphabetical order. ☐

He swapped the position of some elements to fit the pattern of properties. ☐

He left out elements if their properties did not fit. ☐

He left gaps for undiscovered elements. ☐

He changed the properties of the elements to fit the pattern. ☐

[2]

Question 1(b)

(b) The modern Periodic Table puts elements in order of their atomic number.

Table 1.1 shows some information about fluorine and sodium.

Use the Periodic Table to help you to complete the missing information in **Table 1.1**.

Name of element	**Fluorine**	**Sodium**
Group number		1
Atomic number	9	11
Relative Atomic Mass	19	
Number of protons	9	
Number of electrons		11
Number of neutrons	10	

[5]

Table 1.1

Candidates found this to be a successful start to the paper, and many candidates were credited full marks on both part (a) and part (b). Where candidates did fail to score was in part (b) in determining the number of neutrons present in the sodium atom and a common answer here was 1 derived probably from subtracting the number of protons and electrons from the Relative Atomic Mass value for sodium. This clearly demonstrates that centres had focussed on this area of the specification in an appropriate manner dealing with both the Development of The Periodic Table – Mendeleev et al, and the significance of the Mass and Atomic numbers contained alongside the symbol for the elements within the Periodic Table. The success of candidates in tackling this question also shows the usefulness of the Data sheet provided to candidates as many would have used this to answer this question.

Question 2(a)

2 Water is found naturally in very large amounts on Earth.

(a) **Table 2.1** shows some changes that produce water.

Place a tick (✓) in one box in each row to show whether each change is a **physical change** or **chemical change**.

	Physical change	Chemical change
Hydrogen and oxygen combine to form water.		
Ice melts to form water.		
Water vapour condenses to form water.		
Methane burns to form water and carbon dioxide.		

[3]

Table 2.1

Question 2(b)

(b) The different states of water can be explained by the particle model.

Complete **Table 2.2** to describe the particles in the three states of water.

Some have been done for you.

State	Distance between particles	Movement of particles
Solid	close together	
Liquid		slide over each other
Gas		

[3]

Table 2.2

In part (a) candidates were required to indicate whether the change described was a physical or chemical change, many candidates scored full marks here, however when it then came to describing the distance between particles in each of the three states of matter, and the (relative) movement of the particles in 2(b), candidates often struggled to express their ideas clearly. For the solid the expected response was that the particles were 'Vibrating about a fixed position', examiners could accept vibrate on its own, or that the particles 'Do not move' as the limit of acceptability and this allowed many candidates to score 1 mark on this question. For liquids and gases the expected answers were that in a liquid the particles were still close together, although we were prepared to accept answers that described the particles being slightly apart, and for a gas the expected answers should have stated that the particles were far apart and free to move (randomly). Some candidates chose to illustrate their ideas by means of drawing appropriate particle diagrams and provided that these were given basic labels to clearly indicate the correct state of matter, then these were acceptable to gain the marks.

Question 2(c)

(c) Methane and ammonia are compounds also found naturally on Earth.

Table 2.3 shows the boiling point of water, methane and ammonia.

Compound	Boiling point (°C)
Water	100
Methane	–164
Ammonia	–33

Table 2.3

Use ideas about forces between particles to explain why the compounds in **Table 2.3** have different boiling points.

....

....

....

.... **[2]**

This was a question that candidates of all abilities struggled with. The most common incorrect response was to simply restate the data from table 2.3 e.g. Methane has the lowest boiling point and water has the highest boiling point' without making any attempt to link the data to ideas about the forces between particles. However where marks were scored it was often the more able candidates who made the link suggesting that the higher the boiling point the stronger the forces between the molecules. Very few candidates went on to make the link that the stronger the forces the greater the energy required to overcome them and so turn the substance into a gas.

Both marking points could have been achieved had a candidate stated for example that "water has the highest boiling point because the forces between the particles are strong and need a lot of energy to break them".

Question 3(a)

3 Crude oil was formed from plants and animals which lived millions of years ago.

Crude oil contains a mixture of compounds called alkanes.

Alkanes contain only carbon and hydrogen atoms.

(a) What name is given to compounds that contain only carbon and hydrogen atoms?

Put a ring around the correct answer.

Acids **Crystals** **Hydrocarbons** **Salts** **Starch**

[1]

Question 3(b)(i)

(b) The table gives information about some alkanes.

Alkane	Formula	Melting point (°C)	Boiling point (°C)
Methane	CH_4	–182	–164
Ethane	C_2H_6	–183	–89
Propane	C_3H_8	–188	–42
Butane	C_4H_{10}	–138	0
Pentane	C_5H_{12}	–130	36

(i) Describe how the formulae of the compounds change as the molecules of alkanes get larger.

....

....

.... **[2]**

Part a) of this question was correctly identified by most candidates as Hydrocarbons, however in the subsequent questions and sub-sections a variety of responses were evident. In b(i) a significant number of candidates incorrectly tried to make links between the size of the molecules and the melting and boiling point data, rather than focussing on what the question was asking of them. This family of Hydrocarbons is one that they should have studied in detail including drawing structures and naming alkanes extensively as part of the programme of study, and as such these should have been two straight forward marks for candidates to score.

Question 3b(ii)

(ii) Which compound is a liquid at 20 °C?
Use the data in the table to explain your answer.

....

....

.... **[3]**

Candidates often identified pentane as the correct response here, but then did not gain further credit as they struggled to explain that the melting point for pentane is below room temperature (20^{o}C) and that the boiling point is above room temperature, and therefore it is a liquid. The most common mark that was scored in addition to identifying pentane, was to correctly state that it did not change state to form a gas until the temperature reached 36^{o}C which is above room temperature. Along with 3b(iv), what was evident here was that candidates struggled to deal with the concept of negative numbers.

Question 3b(iii)

(iii) What are the general trends in melting points and boiling points of alkanes as the molecules get larger?

[2]

In 3b(iii) The expected response was often given here, candidates correctly identified that as the alkanes increased in size the values for the melting and boiling points increased, and most candidates were credited at least one mark, if not both(see exemplars 1 and 2).

Exemplar 1

Pentane because it has the lowest melting and boiling points. It also liquid at 20°C because its boiling point is 36°C.

[3]

Question 3b(iv)

(iv) Which alkane does not fit the general trend in melting and boiling points?

Explain your reasoning.

[2]

This question was not well answered by the vast majority of candidates. The most common incorrect answer and reason was to identify butane as not fitting the trend as it had a zero/no boiling point. This demonstrates again the fact that candidates at this level have difficulty coping with negative numbers and their relevance to the physical properties of materials. This was a difficult question at this level, but, proved to be significantly more challenging than expected. The question required candidates to look closely at the data provided regarding the melting and boiling points for the first five alkanes. The alkane that did not follow the expected trend was Propane, which was identified by some candidates but they then did not explain their choice correctly, often stating that the melting point was higher than it should be, when it is actually lower than it should be. This further illustrating the issue of negative numbers. This is an area where centres should try to find creative ways to try to help candidates understand this concept and cooperation with colleagues in the Maths departments in centres is encouraged.

Exemplar 2

Explain your reasoning.

Propane as all the melting points are generally decreasing but it increases to being the strongest melting point, when its in the middle of table. [2]

Question 3(c) & 3(d)

(c) All alkanes have the general formula C_nH_{2n+2}.

What is the formula for the alkane that has 8 carbon atoms?

.... **[2]**

(d) Chemists use a range of different separating techniques to separate mixtures.

Which method is used to separate the alkanes in crude oil?

Put a ring around the correct answer.

Chromatography **Crystallisation** **Dissolving** **Filtration** **Fractional distillation**

[1]

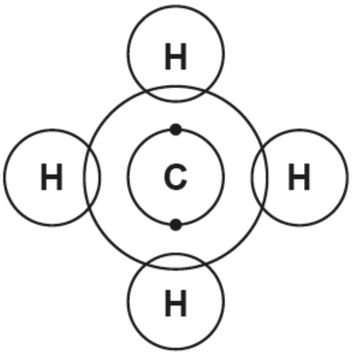
Both of these questions were well answered by the vast majority of candidates. The only really common incorrect response in Q3(c) was to give the number of Hydrogen atoms as 16 rather than 18 by a misapplication of the general formula for alkanes. In question 3d the correct response of 'fractional distillation' was chosen by the majority of candidates and there were no common incorrect responses in this question.

Question 3(e)

(e) The diagrams show the arrangement of electrons in a carbon atom and a hydrogen atom.

A methane molecule contains an atom of carbon joined to 4 atoms of hydrogen.

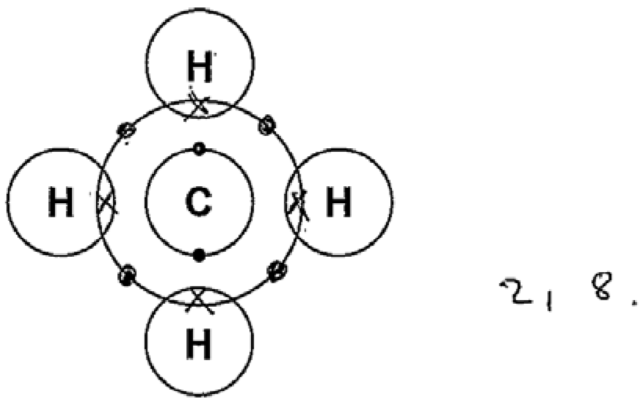
Complete the diagram to show the arrangement of electrons in a molecule of methane.



[2]

Even though candidates were provided with stimulus material that identified the number of electrons on the outer shells of both Carbon and Hydrogen, and crucially their relative positions around the outer shell, there were a number of incorrect diagrams produced. The two most common incorrect diagrams included one where the bond between the carbon and each Hydrogen atom contained only one electron, which scored 0. The other incorrect response was a development from this where in addition to each bond containing 1 electron, on the outer ring for the carbon atom, in the gap between Hydrogen atoms there was an electron drawn such that the outer shell did have eight electrons in total and this was worth 1 mark (see exemplar 3).

Exemplar 3



[2]

Question 4(a)

4 Jack works for a company that makes chemicals for farming. One of the chemicals is copper sulfate.

Jack is looking at ways to make copper sulfate.

(a) Jack adds copper metal to dilute sulfuric acid. There is no reaction.

Which statement explains why?

Tick (✓) **one** box.

Copper is not a metal.	☐
Copper is unreactive.	☐
Sulfuric acid does not react with any metal.	☐
Copper is more reactive than hydrogen.	☐

[1]

There were a number of incorrect responses to this question, the most common being the choice of option 3 about sulfuric acid although this may be a result of candidates extrapolating a trend from the information provided in the stem of the question incorrectly. Candidates ought to have spent time in the lab carrying out salt preparations and working on the reactivity series in such a way that this type of misconception is avoided. There is a need for centres to reinforce this section of learning by providing candidates with sufficient opportunities to carry out examples of different methods of making salts.

Question 4(b)

(b) Jack decides to make copper sulfate by reacting a compound of copper with dilute sulfuric acid.

Which copper compounds react with dilute sulfuric acid to make copper sulfate?

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

Copper carbonate **Copper chloride** **Copper hydroxide** **Copper nitrate**

[2]

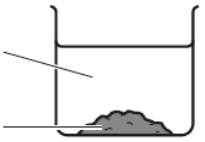
This question reinforces the comments made in the previous section. Many candidates were not credited with any marks here as they choose the incorrect compounds from the list. If Candidates had had the opportunity to make copper sulfate in the lab, using common methods of Acid + Carbonate, Acid + alkali/base, many more would have been able to gain marks from this question.

Question 4(c)(i)

(c) Jack finds out that copper oxide also reacts with dilute sulfuric acid to make copper sulfate.

He adds solid copper oxide to dilute sulfuric acid until no more solid reacts.

At the end of the experiment, Jack has a beaker of dilute copper sulfate solution with some unreacted solid copper oxide.



(i) Which method should Jack use to separate the dilute copper sulfate solution from the solid copper oxide?

Put a ring around the correct answer.

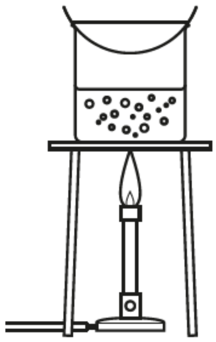
Condensation **Crystallisation** **Distillation** **Evaporation** **Filtration**

[1]

Question 4(c)(ii)

(ii) Jack makes some crystals from the dilute copper sulfate.

He starts by setting up this apparatus.



Describe how Jack can use this apparatus to make crystals.

....

....

....

....

....

.... **[4]**

In 4c(i) despite candidates being provided with a diagram illustrating that there was some unreacted solid present in the beaker, the correct method of separation was not always chosen. This then led candidates into part (ii) where they are asked to describe how to use the apparatus shown to prepare some crystals. Many candidates managed to score two marks here as they correctly stated that they needed to heat the solution to evaporate the water. However, many subsequently did not score any further marks as they went onto state that 'when all the water has been evaporated, leave to cool'. This was taken to mean 'heat to dryness' which is an incorrect method of preparing crystals as it would produce a white powder at best. This is reflected in the mark scheme where it states in the additional guidance "heat to dryness" CON's MP3 and MP4, i.e. 'heat to dryness' is a contradictory statement that negates the accepted responses indicated on the mark scheme in the left hand column. The information provided in the additional guidance column of the mark scheme, is intended for both markers and centres as a guide about what constitutes an acceptable alternative answer, or, as in this case, an answer that is not creditworthy(see exemplars 4 and 5).

Exemplar 4

~~It the~~ The bowl on top will contain the dilute copper sulphate, this will crystalise by the heat making the liquid evaporate and leaving the main copper sulphate to burn and form into small crystals **[4]**

Exemplar 5

The heat of the Bunsen Burner will evaporate the Solution and once the Solution has gone, crystalls should be left over in the beaker **[4]**

Question 4(d)

(d) Jack measures the mass of the copper oxide at the start of the experiment.
He measures the mass of the copper sulfate crystals at the end of the experiment.

The table shows his results.

Mass of copper oxide at start (g)	4.0
Mass of copper sulfate at end (g)	10.0

Calculate the mass of copper oxide Jack needs to use to make 5 kg of copper sulfate crystals.
Give your answer in kg.

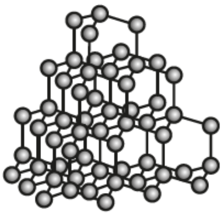
Mass of copper oxide = ... kg
[2]

This proved to be challenging to candidates with very few correct answers being seen. The most common incorrect response was 12.5kg, as a result of dividing the mass of copper sulfate at the end (10.0) by the mass of copper oxide at the start (4.0) and then multiplying this answer by 5. Where a candidate had shown their working to arrive at this value, then, one mark could be credited for the inverse division of 10/4 followed by multiplying by 5 as they had recognised the two operations that needed to be carried out in order to arrive at the answer, but had made one error in their processing of the data and so were allowed one mark. However, an answer of 12.5(kg) with no working evident was credited no marks. This should reinforce to centres the need to instil into candidates the need to show their working in all calculations. Other common errors included multiplying all three values, or converting units (g to kg or vice versa) incorrectly and ending up with very large or very small values.

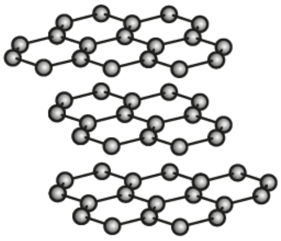
Question 5(a)

5 Diamond and graphite both consist of carbon atoms bonded together.

Their structures are shown below:



diamond



graphite

(a) The table contains some statements about diamond and graphite.

Place **one** tick (✓) in a box for each statement to show whether it is **true for diamond only**, **true for graphite only** or **true for both diamond and graphite**.

Statement	True for diamond only	True for graphite only	True for both diamond and graphite
Every bond in the structure is the same.			
Solid conducts electricity.			
Atoms are joined in a giant structure.			

[3]

Most candidates were credited with at least one mark here for identifying that graphite is the only allotrope named here that conducts electricity. Only a small number of candidates also scored a further mark for identifying both substances as giant structures. Very few candidates were able to link the idea about the bonds to the correct choice. This is a difficult concept for candidates.

Question 5(b)

(b) Graphite is used in pencils.

Use ideas from the structures to explain why graphite can make marks on paper.

Tick (✓) **two** boxes next to the best explanations.

All the bonds in graphite are weak.	☐
Atoms in graphite are in layers.	☐
Forces between layers in graphite are weak.	☐
Every atom in graphite is strongly bonded to four others.	☐

[2]

This was a question for which most candidates were credited full marks. They had clearly studied the bonding and structure in the forms of carbon and correctly identified that the atoms in graphite are in layers and that the forces between the layers are weak.

Question 6*

6* Ropes can be made from different types of fibres.

Some ropes are made using natural fibres made from plants. Some ropes are made using synthetic fibres made from crude oil.

Information about some fibres is shown in the table.

Fibre	**Manila**	**Nylon**	**Kevlar**
Source	plants	crude oil	crude oil
Density (g/cm^3)	1.62	1.09	1.44
Range of tensile strength (N/mm^2)	49–75	62–79	210–350
Stretch before breaking (%)	7	22	3
Water absorbency (%)	33	4	5

Mia wants to buy a rope for climbing.

The best ropes for climbing are made from fibres which are strong and able to stretch. They need to be light in weight, even when wet.

Use the information in the table to choose the best fibre for making a rope for climbing. Justify your answer.

....

....

....

....

....

....

.... **[6]**

Candidates who did well on this question produced responses that were characterised by a logical, thoughtful approach. They often showed signs of having studied the table of information provided and had circled (or ticked) the most appropriate properties for the rope that were in keeping with the description provided in the stem of the question. Consequently these candidates usually chose nylon as their fibre and justified their choice by making appropriate references to the desired qualities and how nylon met these qualities in comparison to the other fibres, thereby matching the Level 3 descriptor (see exemplar 6).

At Level 2, candidates often choose another fibre, most commonly kevlar for its strength, and justified their choice by making comparisons to the other fibres. (see exemplar 7) Although there were also a small number of candidates who did choose nylon, they tried to justify their choice by focussing on the advantages and disadvantages of nylon without making any references to the other fibres.

Very few candidates who attempted this question matched to Level 1 but if a response was at this level it was often characterised by a single sentence making a choice with one advantage (see exemplar 8) Very few candidates scored 0 as they tended to make a choice of a fibre and then try to explain their choice. What was especially pleasing is that there were very few scripts with no attempt made at the question. The majority of candidates could engage with the context of the question and could relate to at some level in order to make an informed choice.

Exemplar 6

6* Ropes can be made from different types of fibres.

Some ropes are made using natural fibres made from plants. Some ropes are made using synthetic fibres made from crude oil.

Information about some fibres is shown in the table.

Fibre	Manila	Nylon	Kevlar
Source	plants	crude oil	crude oil
Density (g/cm^3)	1.62 ✗	1.09 ✓	1.44 ✗
Range of tensile strength (N/mm^2)	49–75 ✗	62–79 ✗	210–350 ✓
Stretch before breaking (%)	7 ✗	22 ✓	3 ✗
Water absorbency (%)	33 ✗	4 ✓	5 ✗

Mia wants to buy a rope for climbing.

The best ropes for climbing are made from fibres which are strong and able to stretch. They need to be light in weight, even when wet.

Use the information in the table to choose the best fibre for making a rope for climbing. Justify your answer. ~~[illegible]~~?) USE DATA.

Nylon would be the best fibre for making a rope for climbing. Although the fibre is made from crude oil and can run out eventually, it contains the best ~~[illegible]~~ products for making the rope. The density is the lowest at 1.09 g/cm³ than ~~[illegible]~~ Manila at 1.62g/cm³ and Kevlar at 1.44 g/cm³ meaning Nylon is light weight. It has a strength of 62-79, not as strong as Kevlar at 210-350N/mm² but ~~[illegible]~~ this makes the material dense. This fibre can stretch up to 22% before breaking. 15% more than Manila and 19% more than Kevlar. Nylon only absorbs 4% of water meaning that the weight does not increase when wet unlike Manila at 33% and Kevlar at 5%. So therefore Nylon is the best ~~[illegible]~~ fibre to use. **[6]**

L3

Exemplar 7

L2

Kevlar would be the best because it has high density compared to Nylon (1.09) but lower than Manila. Manila has the highest density but the lowest strength. Which means that Kevlar has a good density and the highest ~~stren~~ tensile strength. The stretch before breaking is only at 3% which is the lowest. And since water absorbency is needed to be considered it has 5%, not the highest ~~no~~ or the lowest, it only absorbs 5% 5% of water whereas Manila absorbs 33%. The water absorbing should be low because it will add weight on the rope which will make it considerably heavier. It's also made from crude oil which is very good in terms of strength compared to making it from plants. [6]

Exemplar 8

L1

~~Manila, because it~~ Kevlar, because it is very strong. [6]

Question 7(a)

7 Indigestion may be caused by excess acid. Jane investigates indigestion tablets.

The active compound in each tablet is calcium carbonate which reacts with excess acid. Each tablet also contains other ingredients.

(a) The tablets are a formulation and not a pure substance.

Put ticks (✓) in one box in each row to show which statements about formulations and pure substances are **true** and which are **false**.

Statement	**True**	**False**
A formulation is a fixed mixture of pure substances.		
A formulation contains all the same type of atoms.		
A pure substance contains only one compound or element.		
All pure substances are safe to eat.		

[2]

Question 7(b)(i)

(b) The acid in the stomach is mainly hydrochloric acid.

(i) The calcium carbonate reacts with the hydrochloric acid to form calcium chloride, carbon dioxide gas and water.

Complete the **word** equation for the reaction by filling in the missing words.

calcium carbonate + ... → .... + ... + ...

....

[1]

In part (a) of this question candidates usually were credited at least one mark for correctly identifying that option 3 was true and option 4 was false, there was no real pattern to the choices made for options 1 and 2.

In part b(i) more able candidates successfully transcribed the information from the stem of the question into the correct location in the word equation, but lower ability candidates struggled here and many left this blank.

Question 7(b)(ii)

(ii) Jane adds some indigestion tablets to some hydrochloric acid in a beaker.

Jane sees bubbles of carbon dioxide form when she adds the tablets to the acid.

Describe one **other** observation that Jane would see.

....

.... **[1]**

This question was not well answered. Many candidates stated that they would see/hear fizzing which was not creditworthy as they were told that bubbles were seen in the stem of the question. It seems that the link between bubbles and fizzing is not one that candidates make naturally. The question does state in bold in the text **'other'** and so references to fizzing were not acceptable. This suggests that candidates either did not read the question fully, or did not appreciate that they needed to identify something different.

Question 7(b)(iii)

(iii) Jane tests the carbon dioxide that is made.

What is the correct test for carbon dioxide?

Tick (✓) **one** box.

- Relights a glowing splint. ☐
- Pops a lighted splint. ☐
- Bleaches damp litmus paper. ☐
- Turns limewater cloudy. ☐

[1]

Most candidates scored this mark having carried out the gas tests on many occasions as they moved through school; this was one of the most straight forward questions that all candidates could be successful attempting. An area of practical work where there was good evidence of learning having been successful.

Question 7(c)(i)

(c) Jane adds five indigestion tablets to some acid in a beaker.

When the tablets react with the acid, the mass decreases because carbon dioxide gas leaves the beaker.

Jane uses a balance to work out the mass change during the reaction.

These are her results:

Mass of 5 tablets	=	7.55 g
Mass of beaker with acid before adding tablets	=	200.49 g
Mass of beaker and contents at the end of reaction	=	206.24 g

(i) Jane adds the five tablets to the beaker of acid.

Calculate the total mass of the beaker and all of its contents at the start of the reaction.

Total mass of beaker and contents = ... g

[1]

Higher ability candidates scored this mark. Lower ability candidates scored 0 as they either added up all three values, giving an answer of 414.28g, or did not attempt to answer. Centres need to look at how they work with candidates to process data in order to help them to tackle this type of question.

Question 7(c)(ii)

(ii) The mass of the beaker and its contents decreases during the experiment because carbon dioxide is made.

Calculate the mass of carbon dioxide made in Jane's experiment.

Mass = ... g

[1]

Similarly here, it was only the higher ability candidates who were credited this mark. Lower ability candidates gave a variety of responses as it was clear that they were struggling to engage with the question. Many left this blank.

Question 7(d)

(d) Jane finds that the reaction takes a long time.

Give **two** changes she could make to her experiment to make the reaction faster.

1 ....

2 ....
[2]

There were a wide range of responses that candidates could have used here in order to gain marks depending upon how much time they had been given to carry out this type of practical work. Ideas that underpin rates of reaction are a natural area for practical work, and this question tried to assess candidates learning in this area. Although there were many candidates scoring one mark there were two common errors in the descriptions provided by candidates that prevented them from scoring full marks. The first was where candidates wrote 'change the temperature', this was not creditworthy as it did not indicate an increase in the temperature of the reaction conditions. The second was a common misconception amongst candidates. The candidates when discussing acids (or alkalis) often use the term 'stronger' when they are trying to describe an increase in 'concentration'. The most common incorrect response here was 'use more stronger acid' rather than indicating the need to increase the concentration of the acid. This is a difficult concept and candidates of all abilities find it difficult to express their ideas clearly, and centres may find it useful to spend some time with candidates teasing out the difference between strength of acids (alkalis) and the concentration of acids (alkalis) (see exemplar 9).

Exemplar 9

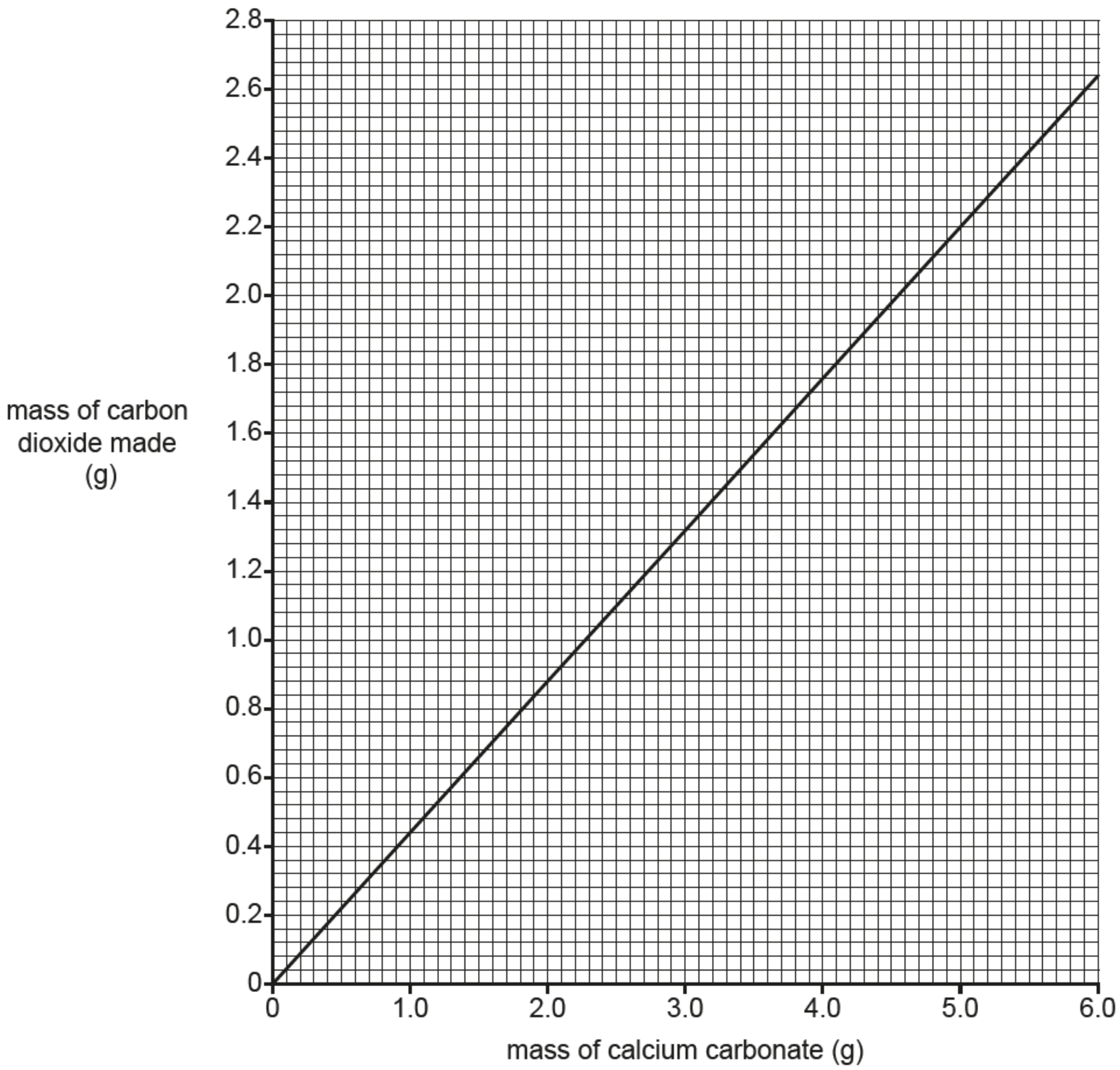
1 by adding biocatalyst inside eg: enzyme platinum

2 changing temperature NBOD
[2]

Question 7(e)(i)

(e) The tablets contain calcium carbonate with other ingredients.

Jane looks at a graph which shows the mass of carbon dioxide that is made when different masses of calcium carbonate react with acid.



The label on the tablets says that **each** tablet contains 0.5 g of calcium carbonate.

(i) Calculate the mass of calcium carbonate in **5** tablets.

Mass of calcium carbonate = ... g

[1]

Question 7(e)(ii)

(ii) Use the graph to predict how much carbon dioxide is made from five tablets.
Show how you used the graph to find your answer.

Mass of carbon dioxide = ... g

[2]

This first part of 7(e) was on the whole well done, candidates picked out from the stem of the question that each tablet had a mass of 0.5g of calcium carbonate, and that they needed to multiply this by 5 giving an answer of 2.5g. However, when it came to transferring this onto the graph and reading a value from the graph, many candidates found this challenging. The most common error was where candidates used the value of 5g (assumed to be from taking 5 tablets) and got an answer of 2.2g. Other common errors arose from candidates inability to recognise the scale used on the y-axis, so that even if they had drawn in an appropriate construction line from the x-axis when this was interpolated with the y-axis answers of 1.2, 1.4, 1.5 etc. were not uncommon. Where candidates had drawn in the appropriate construction lines onto their graphs the first marking point was credited.

Question 8(a)

8 Jamal does a titration to find the concentration of some acid.
He measures the volume of acid needed to react with 25.0 cm^3 of alkali.

(a) What type of reaction happens when the acid reacts with the alkali?

Put a ring around the correct answer.

Crystallisation **Neutralisation** **Oxidation** **Precipitation**

[1]

Question 8(b)

(b) Here are some statements about the steps needed to do a titration.

They are not in the correct order.

A Add an indicator.

B Measure out exactly 25.0 cm^3 of alkali into a conical flask.

C Repeat the experiment until the results closely agree.

D Write down the volume of acid used.

E Add acid to the alkali slowly until the indicator changes colour.

Fill in the boxes to show the **correct order** for the steps in a titration.

One has been done for you.

				C

[2]

Question 8(c)(i)

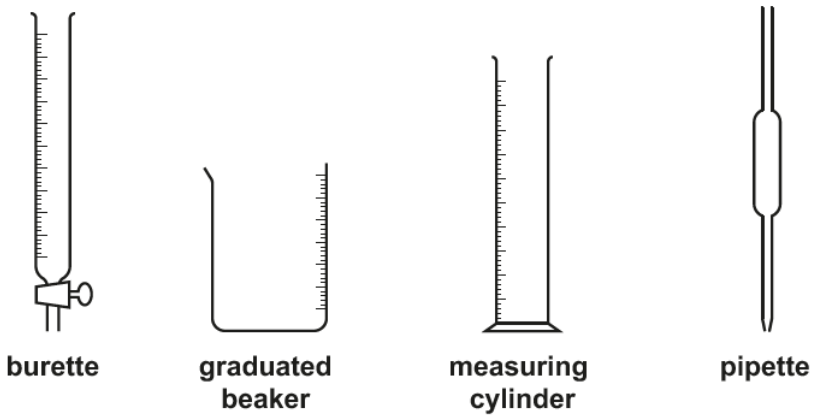
(i) Which is the best apparatus to use to measure out exactly 25.0 cm^3 of alkali into a conical flask?

Put a ring around the correct answer.

Burette **Graduated beaker** **Measuring cylinder** **Pipette** **[1]**

Question 8(c)(ii)

(c) Here are some pieces of apparatus that are used to measure out volumes of liquids.



(ii) Which is the best apparatus to use to accurately measure out the amount of acid needed to react with the alkali?

Put a ring around the correct answer.

Burette **Graduated beaker** **Measuring cylinder** **Pipette** **[1]**

This final question addressing aspects of practical work proved to be challenging to lower ability candidates but was a good source of marks for the higher ability candidates. In part (a) most candidates recognised that the reaction between an acid and an alkali is a neutralisation reaction and were credited this mark. However in part (b) where they had to sequence the events occurring during a titration, many struggled. The most common errors were the positioning of stages B and D within the process. Most candidates correctly recognised that stage A occurred prior to stage E and linked these correctly within their sequence for the procedure, gaining one mark. A common sequence seen was B, D, A, E which gained one mark for A and E together in the correct order, but does not score anything for B and D.

In parts c(i) and (ii) candidates were given standard diagrams illustrating pieces of common laboratory apparatus and asked to identify which piece of equipment was most appropriate for a particular stage within the titration process. The most commonly seen errors were the choice of burette in part (i) and pipette in part (ii), it is encouraging that candidates recognised that these pieces of apparatus were necessary, however, many of them did not recognise the function of each piece within the practical procedure(see exemplar 10).

This suggests that candidates need to spend more time practising these skills in the laboratory.

Exemplar 10

Put a (ring) around the correct answer.

Burette Graduated beaker Measuring cylinder Pipette **[1]**

Put a (ring) around the correct answer.

Burette Graduated beaker Measuring cylinder Pipette **[1]**

Question 8(d)(i)

(d) Here are Jamal's results.

	Rough trial	Repeat titrations			
		1	**2**	**3**	**4**
Volume of acid added (cm^3)	25.2	23.4	23.5	22.1	23.5

(i) Jamal does a rough trial before he does his repeat titrations.

Explain how he uses the result of his rough trial to help him to do his repeat titrations.

....

.... **[2]**

This was probably the least well answered question on the paper in terms of candidate responses. Very few, if any, were credited marks here. Most responses were in terms of using the rough titration as a guide to where to stop the titration, rather than thinking about how they would amend their actual procedure in order to carry out the repeat titrations (see exemplar 11). What was evident was that candidates had been presented with limited opportunities to carry out this type of work and therefore the idea of adding the acid until they were near to the value of their rough titration, (Marking point 1) and then adding dropwise (marking point 2) until the indicator changed colour, seldom occurred to them. Weaker candidates often left this question blank.

Exemplar 11

Explain how he uses the result of his rough trial to help him to do his repeat titrations.

1 It will give him an idea for the sort of results he's looking for 2 Help him perfect his method 3 identify an outlier. **[2]**

Question 8(d)(ii)

(ii) Jamal ignores his rough trial when he processes his results.

What is the range of the results of Jamal's **repeat titrations**?

Range = ... **[1]**

Question 8(d)(iii)

(iii) Identify the outlier in the results of Jamal's **repeat titrations**.

Explain your choice.

....

.... **[2]**

Question 8(d)(iv)

(iv) Use the repeat titration results to calculate the mean value for the volume of acid added.

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

Mean value = ... cm^3 **[3]**

Turn over

Parts d(ii), (iii) and (iv) all focussed on the processing of data collected during a titration. In general, most candidates were able to gain some marks in this section although there were some common errors that were evident.

In d(ii) the range was either stated as $1.4cm^3$, or given as $22.1 – 23.5cm^3$ which was an acceptable alternative and demonstrated that candidates could engage positively with the data.

In d(iii) although many candidates recognised that titration 3 ($22.1cm^3$), was the outlier, they struggled to explain why this was so. The more common incorrect answers were in the form of 'this titration was the only one that started with 22 rather than 23' which was insufficient to gain any credit.

In d(iv) the most common error here was that candidates used all four values from the results table to calculate a value for the mean arriving at a value of $23.135cm^3$, which many often converted to three significant figures as 23.1. Where candidates had shown their working fully then this allowed them to be credited two marks, as they had only made one error in their processing of the data, namely including the outlier. However, if a candidate had not shown their working and had simply written down 23.1 on the answer line then unfortunately they lost all three marks. There is a clear message here for centres to reinforce with candidates the need to show all of their working when tackling calculations, as credit will always be given for the correct application of skills even if there is a minor error contained within the calculation (see exemplars 12 and 13). Exemplar 13 has been credited one mark because they have given the answer although incorrect to three significant figures and shown this in their working.

The only other common error here was where candidates did not address the question fully and did not convert their final calculated value to three significant figures.

Exemplar 12

(iv) Use the repeat titration results to calculate the mean value for the volume of acid added.

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

mean = $\frac{\text{add all.}}{\text{how many there.}}$

3 sig fig

$23.4 + 23.5 + 22.1 + 23.5 = \frac{92.5}{4} = 23.1|25$

23.1

ECF

ECF

Mean value = 23.1 cm³ **[3]**

Exemplar 13

23.125

ECF

Mean value = 23.1 cm³ **[3]**

Question 9(a)

9 The elements in Group 7 (Group 17) of the Periodic Table are called the halogens.

(a) Each element has a different state and colour at room temperature.

Draw lines to connect each **element** with its correct **state** and **colour** at room temperature.

State	Element	Colour
		Green
Solid	Chlorine	
		Dark grey
Liquid	Bromine	
		Pink
Gas	Iodine	
		Red/brown

[3]

Questions 9 and 10 formed the overlap questions with the Higher Tier paper and as such produced a variety of responses. In Q9(a) many candidates were unaware of the physical state of Chlorine and Bromine, and the colours associated with these two halogens. Group VII chemistry is a key area of the specification and the study of this area ought to include reference to the physical properties of the elements, and should have been familiar with Chlorine being a gas. Through carrying out the displacement reactions of Group VII candidates ought to have been familiar with the characteristic colour of Bromine (and Bromine water), and also they may have encountered Bromine water within the context of testing for unsaturation in alkenes. The more challenging aspect here was to identify the physical state of Iodine and to match it to the correct colour of the solid as this is a substance that candidates will be less familiar with.

Question 9(b)(i)

(b) **Table 9.1** shows what happens when some halogens react with hydrogen.

Element	Reaction with hydrogen
Bromine	Reacts steadily when heated.
Fluorine	Explodes at room temperature.
Iodine	Reacts slowly when heated.

Table 9.1

(i) Describe the trend in reactivity of the Group 7 elements with hydrogen.

....

.... **[1]**

Question 9(b)(ii)

(ii) A mixture of chlorine and hydrogen explodes when a small spark is added.

Does this fit the trend of the reactivity of the other Group 7 elements with hydrogen?

Explain your reasoning.

....

....

.... **[2]**

In (b)(i) candidates often struggled to extract the trend from the descriptions provided in Table 9.1 and as such few marks were credited for this question. Many responses often simply rephrased the information from the table without adding anything creditworthy.

In part (b)(ii) of the question, again, many candidates struggled to use the information provided. Responses were often in terms of Chlorine's position within Group 7, rather than in terms of the evidence provided. As such common incorrect responses included; "Yes, because it is second in the Group in the Periodic Table", or "Yes, because it is between Fluorine and Bromine in Group 7", this second response was starting to go in the correct direction but was not deemed creditworthy as there was no comparison with the extent of the reactions between the three elements and Hydrogen. A response that compared the reaction of fluorine with Hydrogen to the reaction between Chlorine and Hydrogen would have been credited a mark, for example 'Fluorine is more reactive because it explodes at room temperature, but Chlorine needs a spark before it explodes' this uses the information and makes a comparison between the two elements. Similarly 'Bromine is less reactive than Chlorine because it reacts steadily when heated and does not explode like Chlorine does' again makes a comparison between the two elements and so would have been credited a mark. Combining these comparative statements would have scored both marks (exemplars 14 & 15 illustrate some of these ideas).

Exemplar 14

Yes, it does fit the trend because although ~~No, it wouldn't explode because~~ chlorines reactivity is smaller than Flourines, ~~and~~ Flourine ~~expl~~ explodes ~~when~~ at room temperatures so adding heat would cause chlorine to explode. **[2]**

Exemplar 15

No because Bromine and iodine react slow and steady when heated, Fluorine explodes at room temprature, No spark is added. **[2]**

Question 9(c)(i)

(c) The halogens also react with reactive metals.

(i) Potassium reacts with bromine to form potassium bromide.

Balance the symbol equation for this reaction.

..........K + Br_2 → ....KBr

[1]

Question 9(c)(ii)

(ii) Other metals also react with bromine to form metal bromides.

The formula of the metal bromide depends on the number of electrons in the outer shell of an atom of the metal.

Complete **Table 9.2** which shows the products formed when different metals react with bromine.

Metal	Periodic Table Group	Number of electrons in outer shell of atom of metal	Ion formed by metal	Formula of metal bromide
Potassium	1	1	K^+	KBr
Magnesium	2			
Aluminium	3			

Table 9.2

[3]

What was very pleasing to see was that many candidates successfully balanced the equation on c(i), this has often been an area where candidates have struggled in the past and so it was good to see so many candidates scoring this mark. Part (ii) was less well addressed. The only mark that candidates scored with any regularity was in identifying the number of electrons in the outer shell of an atom of the metal. This links in with the work on atomic structure and the Periodic Table which was done well on question 1 and candidates who scored marks on question 1 also scored this mark here. However candidates on this tier struggled with the concept of ions and constructing formulae of ionic compounds as this is a very challenging topic and even candidates who would be entered at the Higher Tier often struggle with these ideas. The more common errors were to give the formula of the ions as Mg^+ and Al^+ simply following the lead set by K^+, and similarly giving the formulae of the metal bromides as MgBr and AlBr, again following the example provided by potassium.

Question 10(a)

10 Most cars are fitted with catalytic converters.

Harmful gases from the car engine react together in the converter to form less harmful gases.

(a) The catalyst in the converter increases the rate of the reactions between the gases.

Use ideas about energy to explain how catalysts increase the rate of a reaction.

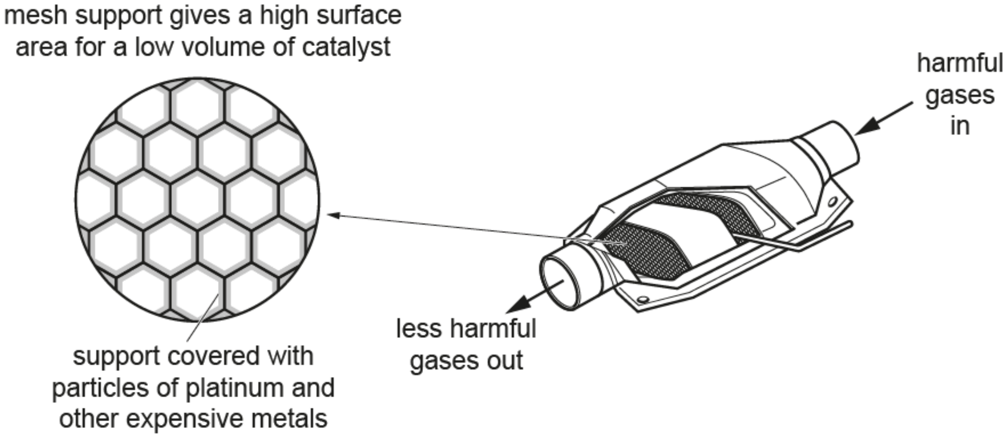
....

.... **[2]**

Candidates knew that catalysts increased the rate of reaction, but as this information was provided to them in the stem of the question, simply re-stating it was not credited any marks. This question was trying to get candidates to focus on the concept of activation energy and the guide provided 'use ideas about energy…' was designed to lead them in this direction. Unfortunately many did not spot, or recognise this and so did not produce answers that were creditworthy. Those candidates who did score a mark here had picked up on the guidance provided and made reference to the activation energy being lowered and gained the second marking point. Very few, if any, candidates made the link with the idea of the reaction taking an alternative route.

Question 10(b)

(b) Platinum and other very expensive metals are used as catalysts in the converter.
Very small particles of the metals are spread in a thin layer over a support.
This means that a very low volume of metals is needed to give a very high surface area.



Suggest the advantages of using a low volume of catalyst with a high surface area.

Low volume ....

....

High surface area ....

....
[2]

Higher ability candidates were able to engage with this question and score at least one mark as they recognised that a low volume of catalyst would result in less of the expensive metal being needed, or that a low volume would reduce costs as less metal was needed. Very few candidates recognised that a high surface area would mean that more collisions would occur. Common incorrect responses focussed on the idea of more harmful gases moving within the exhaust being converted to less harmful products.

For the lower ability candidates this was often a question that was not attempted.

Question 10(c)(i)

(c) (i) The surface area to volume ratio of a particle of a catalyst can be calculated by using this formula:
surface area to volume ratio = surface area of particle ÷ volume of particle

The table shows the particle size and surface area to volume ratio for fine and coarse powders.

Particle	Fine powder	Coarse powder
Size (nm)	500	5000
Surface area to volume ratio (nm^{-1})	0.012	0.0012

How is the surface area to volume ratio of a particle related to its size?

....

....

.... **[1]**

This question was consistently left blank, or was characterised by answers that did not make a link to the data provided. The more common incorrect response was to state that as the particle size increased so did the surface area. Very few candidates seemed to appreciate what the surface area to volume ratio actually meant, as their responses often only made reference to the surface area of the nanoparticle (see exemplar 16).

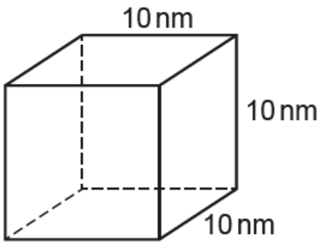
Exemplar 16

The larger the surface area the smaller the volume ratio. NBOD

.... **[1]**

Question 10(c)(ii)

(ii) Catalysts are now made from nanoparticles. A nanoparticle in a catalyst is shown in the diagram.



Calculate the surface area to volume ratio of the nanoparticle.
Assume that it is a cube with sides of 10 nm.

Surface area to volume ratio of the particle = ... nm^{-1}

[4]

END OF QUESTION PAPER

The final question of this paper was a test of candidates' maths skills and as such was often left blank by the lower ability candidates, but was attempted by quite a significant proportion of candidates with varying degrees of success. Those who did attempt this question often scored at least two marks for working out the surface area of one face of the cube, and then calculating the volume of the cube, but were unable to progress beyond this point.

The most able candidates at this level were also able to calculate the total surface area of the cube and to then convert this to the appropriate ratio, being credited full marks.

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