GCSE

COMBINED SCIENCE: TRILOGY

8464/C/2F: Paper 2 Chemistry Foundation
Report on the Examination

8464
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General

Questions 6 and 7 were common to Foundation and Higher tiers and were targeted at grades 4 to 5. In general, demand levels increased from low demand to standard demand through the paper. As expected, students gained credit more readily in the lower demand questions than the standard demand questions. Few questions were not attempetd in the earlier stages of the paper, while a greater proportion of students did not attempt some questions toward the end of the paper. As last year, statistics suggest that this was due to the challenge of the questions, rather than a lack of time. An exception to this was question **04.4**, which was not attempted by about 30% of students.

There is a requirement to include extended response questions - many students found these difficult to score marks on. Correct interpretation of the command word in these, and indeed all, questions is the key to success. The command word for **06.3,** 'Describe' was generally understood by students. However, question **07.2** asked students to 'Evaluate', which expects students to give a judgement strongly linked and logically supported by a sufficient range of correct reasons.

Students are strongly encouraged to use scientific terminology. The use of the word 'amount' is unlikely to gain credit (question **03.5**). Students are encouraged to specify more clearly using terms such as 'volume' or 'mass'.

The requirement, for 20% of marks across the chemistry questions to be mathematically based, continues to challenge students. There were good attempts at the questions relating to the graph in question **02**, and the bar chart in question **05**, but the concept of conservation of mass in question **05.3**, and the ideas of ratio and percentage in questions **06.4** and **06.5** led to a high proportion of attempts gaining zero marks. In question **06.4**, the conversions between mg and g, together with cm^3 and dm^3 were often not attempted. Where they were attempted, a factor of 100 was often used, rather than 1000.

There is a requirement to include some questions to test recall. These were often poorly answered, for example the chemical tests in questions **01.2** and **04.4** were not well known.

As always, students are reminded to write in black ink. Where handwriting is poor, examiners make every effort to read what is written, but some answers can be difficult to read.

Levels of demand

Questions are set at two levels of demand for this paper:

- **low demand** questions are designed to broadly target grades 1–3
- **standard demand** questions are designed to broadly target grades 4–5.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

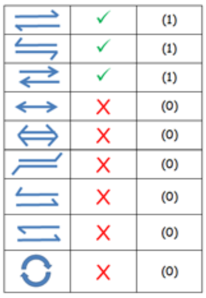
Question 1 (low demand)

01.1 About 80% of students were awarded at least one mark, while around 30% correctly identified all three substances. Carbon dioxide was often mistaken as a hydrocarbon. When one mark was given, this was most often for recognising that oxygen is an element. It appears that students have more difficulty distinguishing mixtures and compounds.

01.2 At least one of these tests was known by about 64% of students, with around 27% remembering both. Using a lighted splint to test for oxygen was a frequently seen mistake and litmus paper was often erroneously used to test for either gas.

01.3 About 71% of students gave at least one correct reason for the decrease in the percentage of carbon dioxide in the air over the last 2.7 billion years, but less than a quarter of students gave two correct reasons. ‘Combustion’ was a commonly chosen distractor.

01.4 More than half of the students gave an acceptable response, most using the standard symbol, but frequently seen alternatives included:



Some students suggested a variety of chemical formulae.

01.5 This was correctly completed by about 82% of students.

01.6 Only around 18% of students knew that the forward and reverse reactions happen at the same rate or speed. The incorrect response which was most frequently seen was time.

Question 2 (low and standard demand)

02.1 ‘Formulation’ was selected by approximately 42% of students, with ‘formula’ proving to be a common incorrect choice.

02.2 Approximately 30% of students were awarded both marks for correctly stating that silicon dioxide has a giant structure and strong covalent bonds. Although about 79% of students gained at least one mark, the terms covalent and ionic were not always used correctly. ‘Weak intermolecular forces’ was a common error.

02.3 The correct examples of both variables were selected by around 14% of students and around 43% were able to select one correct example. Of those awarded one mark, the control variable was most commonly correctly identified.

02.4 This question enabled three quarters of students to gain at least one mark by plotting a minimum of three points correctly and about 58% gained at least two marks. Around 16% were awarded all three marks. Some students made an error plotting one of the points; others were able to plot the points, but did not earn the final marking point for the line of best fit. Some students were unable to plot any points correctly. Some students incorrectly attempted to draw a straight line as a line of best fit.

Large, heavy crosses make it difficult for examiners to determine whether the plotted points are within tolerance and risk not being able to gain credit. Often, lines were wavy rather than smooth.

02.5 Three quarters of students gained at least one mark for correctly identifying 1500g as the mass of stones at the highest point on the graph. Some students identified this mass, but gave as their reason that this made the strongest concrete, which repeated the stem of the question and gained no further credit. The most commonly seen incorrect mass of stones was 2750g, presumably taken from Table 1.

While about 46% of students were able to express the reason for their choice clearly, some struggled with either terminology or trying to express the idea of the highest weight or the highest point of the graph. A very small minority gave 110 (g) as the maximum mass of stones. Some students gave a reason that 110N needed to break the beam without explaining this was the highest weight.

Others gave a comparative in their reason rather than a superlative, eg suggesting that concrete made with 1500g of stones needed 'more' (rather than 'most') weight to break.

02.6 The idea of doing more tests or taking more measurements to improve an investigation was widely understood. About 64% of students gained this mark for any indication that more results would improve the investigation. However, responses such as 'make the graph bigger' were too imprecise for credit, as this could be interpreted as extending the range of results or literally drawing a bigger graph without any extra data.

Question 3 (low demand)

03.1 Approximately 58% of responses were correct. About half of the students giving incorrect responses gave '4' instead of '2', but the remaining students often gave a chemical formula, eg 'H', 'Cl', 'CO_2', or 'H_2O'. As expected, multiples of the equation were rarely seen.

03.2 The use of a measuring cylinder to measure with the greatest accuracy was correctly indicated by about 73% of students.

03.3 There were many excellent responses, with about 42% of students gaining four marks by including headings, correct units, time values which were appropriate for the units and corresponding volumes of gas.

Students who did not gain full marks commonly made a mistake with the units for time, for example giving units as minutes (creditworthy), but then listing times as '0.20, 0.40' etc. not realising that 20 seconds is not 0.2 of a minute. Other students implied that there are 100 seconds in a minute by writing '20, 40, 60, 80, 1 minute'. '2, 4, 6, 8, 10, 12' were also seen as time values. Some students wrote 'Gas produced' or 'Amount of gas' as a column heading, omitting to state that it is the volume of gas which was measured, and others wrote a unit of time but omitted the word 'Time'. Around 63% gained three or more marks.

A small minority of students completed the table but omitted both headings and units. Most students who successfully gained mark points 1 and 2, also completed the table correctly to gain the further two marks.

About 13% of students were unable to gain any marks for this question.

03.4 About 15% of students gave creditworthy responses. The correct responses mainly focused on the escape of gas or a suggestion that the concentration of the acid may have been too low. Answers not gaining credit often related to time, or were imprecise; for example, for a mention of temperature to gain a mark, the student had to state that the temperature was too low, not just different.

03.5 Only around 3% of students were awarded both marks, while approximately 15% were awarded one mark. Many responses were not creditworthy due to imprecision, for example ‘amount of acid’ or ‘amount of magnesium’ or simply ‘magnesium’. Many students suggested that the same apparatus should be used or that an aspect of timing should be kept the same.

Of the correct responses, the distribution was roughly equal between the mass (or another acceptable characteristic) of the magnesium, volume of acid and temperature, although a small minority suggested that the temperature of the room should be constant, which did not receive credit.

Some students suggested that the gas **used** should be kept constant, which did not gain credit.

03.6 This question enabled around 88% of students to demonstrate their understanding of reaction rates by giving at least one creditworthy response. About 35% of students gained all three marks and about 69% were awarded at least two marks. The second sentence was least likely to be correctly completed, with the response of concentration or incorrect particles, eg atoms.

Some students completed the final sentence with ‘faster’, ‘quickly’, ‘rapidly’ or ‘vigorously’. These were not accepted as they could imply that the collisions were more energetic rather than of increasing frequency. ‘Successfully’ was not sufficient for the mark.

Question 4 (low and standard demand)

04.1 Conditions for cracking were not well known, with only around 5% of students gaining both marks, usually for stating ‘high temperature’ and ‘catalyst’. Nearly 63% of students were unable to give any required conditions. Responses commonly included descriptions of the purpose of cracking or the outcome of cracking.

Responses which were insufficient for credit included ‘heat’, ‘temperature’, and ‘pressure’.

04.2 The displayed structural formula for butane was clearly drawn by about 40% of students. However, 25% of students gave no response. The most commonly seen incorrect response was the formula for ethane, shown by adding just ‘H’ to the partial formula given. A very small minority of students attempted to complete the formula by adding ‘H’ within the carbon chain.

04.3 About 11% of students gained both marks by giving carbon dioxide and water. Butane oxide was commonly seen, often paired with hydrogen. Carbon and hydrogen was another incorrect combination. A small number of students wrote formulae. When correct, these were credited. Students giving either carbon dioxide or water gained one mark, with numbers approximately equally split between these two alternatives.

04.4 The test for alkenes using bromine water is not well known, with just around 5% of students awarded both marks and 8% at least one mark. It is apparent that students are not remembering this simple test. Students appeared to confuse ‘alkene’ with ‘alkali’, as the most frequently seen incorrect tests involved testing for pH (eg universal indicator or litmus). Testing with limewater or a lighted or glowing splint was also seen. A very small minority of students knew the use of bromine water to test for alkenes, but were unable to give the correct colour change.

04.5 **‘**Sustainable development’ was correctly identified by half of students.

Question 5 (low and standard demand)

05.1 The percentage by mass of calcium in the Earth’s crust was correctly read from the bar chart by about 80% of students.

05.2 Around 84% of students gained credit for this question. A very small minority of students drew a bar which went above the tolerance (± half a small square from 2.1%). An even smaller minority drew a bar to a completely different percentage. There were few blank scripts.

05.3 About 29% of students reached the correct answer. Many students carried out a variety of mathematical operations on the numbers provided. Some added them all, others did a single subtraction and some multiplied two or all three of them together. Some students carried out a potentially correct calculation, but instead of using all three numbers, used one of them twice and omitted the remaining one:

eg: 648 – 617 – 31
617 – 31 = 586.

05.4 Almost a fifth of students correctly identified the activation energy on Figure 7. A tolerance was allowed for the placing of the start and end of the arrow. The most frequently seen error was to draw an arrow from the energy level of the products up to the maximum of the curve, but some students drew horizontal arrows, arrows following the curve or labelled the top of the curve as the activation energy. A number of students drew an arrow indicating the point at which the energy level starts to rise from the middle of the reactant line.

05.5 About 8% of students were awarded two marks. Many incorrect responses featured vertical or horizontal arrows in a wide variety of places on Figure 8. Many responses also labelled reactants, products or the maximum of the given profile. Some students attempted a curve, but drew it going above the existing profile, or starting and ending at energy levels other than those given.

05.6 Enzymes were recognized by around 60% of students as catalysts in biological systems.

Question 6 (standard demand)

06.1 Less than half of the students correctly identified water that is safe to drink as ‘potable’.

06.2 About 3% of students recalled that a test for pure water is to boil it and that the boiling point would be 100 °C. Approximately a further 11% suggested ‘boiling’, but did not indicate the boiling point. These students may have interpreted the question as asking how to purify water, as others gave answers such as desalination or filtering.. A number of students also suggested that if the water is ‘clear’, then it is pure and safe to drink. Others suggested drinking it and seeing if they became ill.

Many students suggested using an indicator. A small number of students gained the compensation mark by suggesting evaporation or distillation **and** adding that no solid would remain.

06.3 This was an extended response question, with four marks, at two levels. Students were asked to describe a method to determine the mass of dissolved solids in a $100cm^3$ sample of river water.

The key requirement for access to level 2 was that the method should produce a valid outcome. This needed some mention of the sample, or a known volume of water, heating until dry and determination of the mass of the solid. Only about 6% of students were able to describe a method which would provide a result.

Around 27% of students omitted one or more steps from their method, limiting themselves to a mark in level 1. Most frequently, students omitted to mention that a known volume of water or the $100cm^3$ sample should be used. Others heated an appropriate sample, but omitted to weigh the remaining solids.

Many students suggested filtering the water sample. Provided this was to remove solids from the water before heating, this would be a valid approach. However, a substantial minority of students described filtration as the method to remove dissolved solids, which is incorrect.

A small minority of students also described the stages of water treatment or described methods to obtain water from a river.

06.4 This question proved challenging for many students.

The allocation of marks was for the volume conversion (1), mass conversion (1), the calculation (1), and the answer to 2 significant figures (1). A correct answer was awarded all 4 marks, provided the working was commensurate with the answer. Less than 1% of students gained all 4 marks, but around 32% made a creditworthy attempt.

The most frequently awarded mark was for the calculation (mark point 3). Some students divided rather than multiplied the numbers given: 250 and 125, producing answers such as 0.5 or 2.

The mass and volume conversions proved challenging but the answer was often correctly given to 2 significant figures. However, some students gave 31250 to two significant figures as 31. Some students attempted the conversions, often dividing by 10 or 100 rather than 1000, or multiplying rather than dividing.

06.5 More than a third of students completed this calculation successfully. Of those who did not, most inverted the calculation, working out 500 × $\frac{44}{500}$, or did not multiply by 100, calculating $\frac{44}{500}$.

Question 7 (standard demand)

07.1 The production of oxides of nitrogen in car engines did not appear to be well known. 4% of students gained at least 1 mark, usually for stating that oxygen and nitrogen react. However, some students stated that the nitrogen originated from the fuel, which was not creditworthy. Very few students gained both marking points. A small minority referred to the heat in the engine, but this was insufficient for MP1, which required an indication of high temperatures in the engine.

07.2 This standard demand question proved accessible to most students. Despite this, it was not attempted by around 17% of students. About 4% of foundation tier students achieved a mark in level 3, with around 28% reaching at least level 2.

The command word for this question is 'Evaluate'. The command word 'Evaluate' expects students to give a judgement strongly linked and logically supported by a sufficient range of correct reasons. Most students at this level gave only a weak judgement, if any at all. The few judgements that were seen were often simply a sentence at the end of the answer offering an opinion, or referring the reader back to the main body of the answer. To be a valid level 3 judgement, students should directly link the judgement to items of data drawn from Table 3.

A substantial number of students gave linked comparisons between the cars, or linked a judgement with a single reason, for example, 'Car A produces the least carbon dioxide during manufacture, but the most per km when driving'. These students were awarded a mark in level 2.

The majority of students gave single comparative statements drawn from the table without linking them together, for example, 'Car C produces the most carbon dioxide when it is manufactured'. These students were awarded a mark in level 1.

Weaker responses chose not to use the information in Table 3, but wrote in general terms about the damaging effect of cars on the environment. Others who used Table 3, often repeated the information in the table, without adding any additional value. Some confused masses of carbon dioxide with masses of the cars, for example, 'the heavier the car during manufacture, the lower the amount of carbon dioxide produced when driving'. Some students speculated about the nature of the car, indicating possible size, mass or type of fuel used. This did not gain credit.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.