GCSE

COMBINED SCIENCE: TRILOGY

8464/C/2F

Report on the Examination

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General

Questions 6 and 7 were common to Foundation and Higher Tiers and were targeted at grades 4–5. Students should be prepared to expect unfamiliar contexts and information to assess the objectives in the specification. Familiar contexts are those mentioned in the specification and assess recall, selection and communication of students' knowledge and understanding.

The demand levels of the questions are designed to increase from low demand to standard demand through the paper, and as expected, students had more difficulty gaining credit in the standard demand questions towards the end of the paper. It appeared that most students had sufficient time to complete all the questions, although a higher proportion of some of the standard demand questions were not attempted. Statistics suggest that this was due to the challenge of the questions, rather than lack of time.

The requirement across the chemistry questions on the specification is for 20% marks to assess mathematical skills, and many students made good attempts at these questions. The only exception to this was question **07.3**, which proved challenging.

Papers must also include questions about the Required Practical Activities. On this paper chromatography was included. It was clear from some students' responses that their experience with this practical activity was either limited or too long ago to remember. First-hand experience of practical activities is crucial for students to perform well on practical-based questions on the paper.

Questions based directly on recall of newer sections of the specification were not answered so well, eg questions **04.5** (What is a formulation?) and **06.7** (Why are life cycle assessments done?).

Some students struggled with the extended response questions. Understanding the command word is key to success in these questions. Question **06.8** asked students to 'Compare', and question **07.5** asked students to 'Explain'. In both cases a number of students gave a description but did not go on to offer a comparison or explanation.

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 45% of students achieved this mark. Common errors included 32 (most frequently seen), but also 48 and 8.

01.2 62% of students achieved this mark. Of those who did not gain credit:

- about half gave electronic structures which showed no understanding of the maximum number of electrons in any given shell
- about half were aware that there should be no more than 8 electrons in the 2nd and 3rd shells, but gave, for example, 6 electrons in the 2nd shell and 8 in the outer shell.

01.3 59% of students achieved this mark. Some students gave '=' in place of the '→' in the equation, but this was allowed.

Many of the incorrect responses indicated that students were not able to recognise that an equation has reactants and products separated by an arrow, and therefore do not understand the concept of an equation. These students often simply wrote 'oxygen' or another similar single word on the answer line. Some students added further products, eg carbon dioxide, hydrogen or water. A few students failed to gain credit because they wrote 'sulfur oxide' as the product.

01.4 77% of responses were correct with global warming as the most popular incorrect answer.

01.5 This question discriminated between students well. 61% of students achieved full marks and correctly described enough of the graph, including year ranges, to demonstrate that the mass of sulfur dioxide in the atmosphere did not decrease every year in the period shown in Figure 3. A very good proportion of students were able to correctly read from the *x*-axis to give year ranges.

Lower-attaining students were unable to give accurate year ranges, although most gained at least one mark by describing the change in mass of sulfur dioxide in one or more of the three main time periods without referring to correct year ranges.

01.6 81% of students gave a correct answer with clear working, achieving two marks.

Some students confused the percentage calculation with angle measurement on the pie chart. So although they realised that industry represented a quarter of the pie chart, they took 360°, divided by four, and gave 90(%).

Others misread the value of 6% for transport, and added 9 to 69, giving 78%, and a final answer of 22%. This achieved one mark. Some students correctly calculated 75 for one mark, but then subtracted this from 360, giving an incorrect final answer of 285(%). Others multiplied or divided the values of 6 and 69, achieving no marks.

Question 2 (low & standard demand)

02.1 65% of students achieved the first marking point by stating that red and blue were in the black ink, but only a very small proportion correctly identified the other colour as unknown. Some students attempted to identify the remaining colour as green.

Provided students only gave three colours, the first marking point for red and blue was still awarded. However, when a list of four or more colours was given, the list principle was applied.

02.2 70% of students achieved the first marking point for stating that the least soluble colour was red. A sizeable minority of students thought that the least soluble colour could be green or black. 32% of students were able to give a correct reason.

A comparison with the other colours, the start line or the solvent front, was needed so answers such as ‘it doesn’t move far’ were not credited. Some students incorrectly suggested that the red colour did not move at all up the chromatography paper, or that the reason related to the darkness of the colour or its reactivity.

02.3 19% of students correctly measured both distances and were able to complete the calculation correctly. A range was allowed for the measurements.

Some students confused units, perhaps measuring in centimetres, or suggesting 120 mm and 360 mm instead of 12 mm and 36 mm respectively. Others were able to measure the distance of the green colour from the start line, but gave measurements such as 20 mm for the distance moved by the solvent front. This suggests that the term ‘solvent front’ may be unfamiliar.

A small number of students inverted the calculation, and some incorrectly rounded their final answer. Students were still able to gain the two calculation marks with incorrect measurements. It appeared that some students may not have had access to a ruler.

It was clear that a small minority of students were completely unable to access the question, as they gave descriptive answers for this numerical response.

Question 3 (low & standard demand)

03.1 44% of students correctly selected ‘watch glass’. However, almost an equal number of students selected ‘condenser’, suggesting unfamiliarity with this required practical.

03.2 24% of students achieved all three marks, and 30% achieved two marks. Most students understood the basic concept of finding a mean, although there were a variety of errors. The most commonly seen error was to include the anomaly, 0.29 in the calculation. These students achieved a maximum of two marks for a correctly calculated answer from this.

Other students did not give the answer to two significant figures, either giving the wrong number of significant figures or rounding incorrectly. They also achieved a maximum of two marks if the rest of the calculation was correct.

There was evidence of incorrect addition and division, suggesting that some students did not have, or were not able to correctly use, a calculator.

03.3 Evaporation as a change of state was well known, and frequently given, along with the description, turning form a liquid to a gas. 41% of students were achieved this mark.

Commonly seen incorrect responses were ‘condensation’, ‘boiling’ and ‘bubbling’. Some confusion between evaporation and condensation was evident. Answers such as ‘heating’ or ‘change in temperature’ indicated that the concept of change of state was not recognised by these students.

03.4 51% of students gained credit, mostly for stating that the water in the test-tube contains no salt. A smaller proportion stated that it is pure.

Many of the incorrect responses indicated a weak understanding of distillation, often referring to the water being filtered, or made clean, or the salt evaporating. Other students described part of the distillation process, but did not suggest in what way the water in the test-tube was different. Answers suggesting that there was less salt in the test-tube water were not credited as there would be no salt.

03.5 27% of students recognised that energy costs are the greatest contributor to the expense of distillation. Commonly seen incorrect responses often referred to the cost of equipment, of the workforce, of the scale of the process or of the time taken for the process. Some students are confusing distillation with filtration, suggesting that the cost of filtering is the main expense.

03.6 47% of students achieved one mark, and 165 achieved both marks. Students gaining credit often gave clear, precise responses with correct terminology. Responses which were less precise did not gain credit, for example filtering or sterilising makes the water clean, or sterilising is to remove bacteria.

Some students did not understand the concept of filtration, suggesting that it would remove salt or bacteria from the water. With sterilisation, bacteria are killed or destroyed, not removed. Less precise responses such as removal of germs or diseases were not credited.

Question 4 (low & standard demand)

04.1 A majority of students indicated that nitrogen makes up 20% of the Earth's atmosphere, suggesting confusion with oxygen. 32% of students correctly ticked the box for 80%.

04.2 24% of students knew a source of nitrogen in the first billion years of the Earth's existence, most suggesting volcanoes. The students who did not gain credit often forgot that they were asked to consider this time period and gave an answer from modern times, eg fertiliser, plants, animals, or human activity such as transport.

Some students revealed a misunderstanding of basic chemical principles in giving answers such as oxygen, argon, carbon dioxide or water. These elements and compounds contain no nitrogen, so cannot be its source.

04.3 35% of students achieved this mark by giving an acceptable symbol for a reversible reaction. Some students added further reactants or products, which were ignored. Incorrect responses included ↔ and ≡

04.4 'Time' was a frequently seen incorrect response. 16% of students achieved credit for a response such as rate, speed or pace.

04.5 There were some very creative attempts at this question, however, the definition of a formulation was not well known. 4% of students were awarded this mark. There were a small number of accurate, succinct responses, but although a larger proportion of students realised that a formulation is a mixture, few were able to add that it has a use or purpose.

Some students were able to give examples, but not a definition. Others confused formulation with formula, defined a compound, or suggested that a formulation is a compound designed as a useful product.

04.6 82% of students achieved this mark with a clearly drawn bar to 5.8%. A tolerance of ± ½ square was allowed, but rarely needed. Some students appeared to mistake the scale and counted down two small squares from the 6.0% line, giving a bar to 5.6%, rather than the 5.8% they expected. A very small minority of students drew bars which finished a long way from the 5.8% line.

04.7 Most students were aware that $\frac{3.0 \times 100}{0.225}$ was **not** a correct calculation for the percentage of iron in the fertilizer. However, the other three options proved almost equally popular, suggesting that many students find percentage calculations challenging. 39% of students achieved a mark here.

04.8 This question discriminated well. 92% of students were able to access this question and achieve at least one mark by agreeing that the use of fertilizer increased.

Many students continued to provide some data from Figure 9, with 51% achieving two marks. A large proportion of students gave data from a country chosen to exemplify this, while others added the totals for 2003 and 2015.

10% of students went on to recognise that the increase in fertiliser use differed between the countries in Figure 9, and that in countries A or C the difference was 'much larger' but that it wasn't 'much larger' in countries B or D.

Question 5 (standard demand)

05.1 A substantial number of students found selecting the independent and control variable challenging. Of these students, some gave multiple suggestions, and others gave the control variable as the independent variable and vice versa. The mass lost from the flask, and the time taken were frequently selected. A number of students ignored the instruction to 'Draw **one** line from each type of variable' and drew several. 30% of students achieved one mark and 15% achieved two marks.

05.2 24% of students were able to name all the products of the reaction, although 40% named two. Among the incorrect responses, many students named elements in the products (eg hydrogen or calcium), and others were unable to distinguish reactants from products.

While some students appeared to readily recognise $H_2O_{(l)}$ as water, others referred to it as hydrogen oxide. Other students were unable to name calcium chloride, leaving it as 'calcium'. Many incorrect responses included cobalt.

05.3 6% of students answered this question correctly. Of these, only a very small proportion of students realised that the cotton wool prevents acid or water escaping from the flask. By far the most commonly seen response suggested that the cotton wool prevents the escape of gas from the flask. Other students suggested that it prevented heat loss, or stopped air or oxygen from getting in the flask.

05.4 72% of students successfully calculated the mean rate of the reaction. Of those who did not succeed, most had difficulties with powers of ten, giving answers such as 5.3 or 0.53. A smaller proportion of students inverted the calculation, giving the answer as 18.75 (= 30 ÷ 1.6). Some students attempted to multiply 1.6 × 30.

05.5 78% of students selected the correct response, g/s. The most popular incorrect responses were g and s.

05.6 This question discriminated well with a nice spread across the mark range. 66% of students achieved at least one mark, with 11% achieving all three.

Lower-attaining students were challenged by the *y*-axis scale and attempted to plot a graph using a scale of one small square to 0.1 g rather than two small squares to 0.1 g.

The points requiring a reading of the *y*-axis scale for 0.8 g and 1.8 g proved more difficult than those at 0.6 g and 1.6 g. This resulted in difficulty drawing a sensible line of best fit. Some students omitted to plot the point at (0,0).

A number of students who succeeded in plotting the points correctly interpreted the term 'line of best fit' as requiring a straight line, whereas a curve was correct. The term 'line of best fit' applies to either a straight line or a curve. Most students realised that the point at 20 s was an anomaly, and excluded it from their line of best fit. Some students attempted a bar chart.

05.7 Most of the responses were almost equally divided between the 2nd and 4th responses, indicating that students were aware that more frequent collisions were involved, but unsure whether thee eight small marble chips had a larger or smaller surface area than the large marble chip.

Question 6 (standard demand)

06.1 58% of students selected the correct response ‘condenses’. The most commonly seen incorrect answer was ‘dissolves’.

06.2 54% of students recognised that the fractions separate due to different boiling points.

06.3 15% of students gained credit, recognising the alkane to be propane. This suggests that students are not familiar with the use of models to represent alkanes.

06.4 The correct answer of C_nH_{2n+2} was the most commonly chosen, by 42% of students, although C_nH_{2n} proved an effective distractor.

06.5 Balancing an equation such as this combustion of methane was very demanding for the vast majority of students. 13% of students achieved this mark.

Multiples were accepted. Some students who did not gain credit had a valiant attempt at balancing, evidenced by their calculations and working alongside the question. Others had little idea, either inserting a variety of numbers and / or formulae on the answer lines, or simply not attempting it.

06.6 The correct answer of bromine water was the most commonly chosen, by 44% of students, although limewater proved an effective distractor.

06.7 8% of students knew the definition from the specification, or were able to give an equivalent statement. A large number of vague responses were seen such as ‘to see how we can do things better’.

06.8 The least creditworthy responses discussed in general terms the effect on the environment of burning waste plastic and using landfill. Students writing these responses made little reference to the information in Table 6, and many of these students missed the key command word, 'Compare'.

13% of students achieved marks in level 1 by giving some comparisons of the gases and residue either in qualitative terms or by quoting values from Table 6. To access level 2, students were expected to 'note the magnitude' of the differences, as stated in the generic level descriptor in the mark scheme. 30% of students were awarded a level 2 mark.

Some students had difficulty interpreting the information in Table 6, reversing the causal relationship, and attempted to suggest that the emissions caused the disposal method. A number of students were unable to express the comparisons clearly or accurately, for example suggesting that the processes used carbon dioxide or sulfur dioxide, or writing that landfill increases the sulfur dioxide by 10%. Some students' calculations from Table 6 were incorrect, for example the difference the mass of sulfur dioxide produced by the two methods was sometimes given as '10', and the difference between the mass of solid residue given as '20'.

Students did demonstrate a good understanding of environmental responsibility

Question 7 (standard demand)

07.1 63% of students recognised methane as a greenhouse gas. Nitrogen was the most commonly seen incorrect response.

07.2 This question discriminated well. 29% of students were able to name two effects of climate change, with the next 33% naming one effect.

Students who did not gain credit were sometimes too vague, for example giving responses such as unspecified changes in the weather, or unspecified effects on people. Others gave causes rather than effects of climate change, or referred to acid rain, pollution or ozone.

07.3 Many students found this calculation challenging with 3% of students able to give the correct answer. 70% of students managed a single division or multiplication with two of the numbers given, but were unable to continue to complete the calculation required. Some of those who knew the correct method failed to convert from grams to kilograms, but were still able to access one of the two marks. Some students were able to apply the correct method, but did the calculation in two parts, and their rounding after the first part gave rise to an incorrect final answer. Students should be aware that they should not do any rounding until they reach their final answer.

07.4 13% of students suggested using less plastic or recycled plastic, or gave a reference to carbon capture. Some incorrect responses focussed on the disposal, including burning, rather than the manufacture of plastic. Planting trees to capture the carbon proved a popular idea.

07.5 This ‘extended response’ question discriminated well. It asked for an explanation of how the levels of three gases have changed since the Earth’s early atmosphere. To achieve marks in level 1, statements of change for the three main gases in the Earth’s atmosphere was required. When explanations were linked to the changes, marks in levels 2 or 3 were awarded. The clearer, more logical and more detailed accounts achieved level 3 marks.

4% of students achieved a level 3 mark on this standard demand question. Some accurate and well expressed responses were seen, succinctly explaining the changes to all three gases. The most logically sequenced of these discussed each of the three gases in turn, resulting in very readable and accessible accounts. A further 12% of students achieved a level 2 mark, and a further 32% achieved a level 1 mark.

Many of the lower-attaining students discussed modern day changes to the Earth’s atmosphere, rather than addressing the changes since the Earth’s early atmosphere. These students attempted to explain increases in carbon dioxide levels due to industrial or other human activity, and decreases in oxygen due to increasing population. Some students included mention of the ozone layer. Some of these accounts were less logically sequenced and suggest that lower-attaining students are more challenged by the concept of evolutionary timescales, or are failing to read the question carefully.

As mentioned in the general comments for this paper, students should note the command word for an extended response question carefully. In this question students were asked to ‘Explain’. Many students qualitatively described the changes in amounts of nitrogen, oxygen or carbon dioxide since the Earth’s early atmosphere, but were not successful at linking these changes to explanations. When students did attempt an explanation, the effects of photosynthesis on changes in the percentages of oxygen and carbon dioxide were better known than those of volcanic action on the change in percentage of nitrogen.

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.