GCSE

COMBINED SCIENCE: TRILOGY

8464/C/2H
Report on the Examination

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General

Questions 1 and 2 were common to the 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 standard demand to high demand through the paper, and as expected, students had more difficulty gaining credit in the high demand questions, particularly question **06.2** to **06.5**, towards the end of the paper. It appeared that the majority of students had sufficient time to complete all the questions.

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 **04.2**, which proved particularly challenging.

Questions based directly on recall from newer sections of the specification were not answered so well, eg question **01.7** 'Why are life cycle assessments done?' and question **04.1** 'What is a formulation?'.

A few students struggled with the extended response questions. Understanding the command word is key to success in these questions. Question **01.8** asked students to 'Compare', and question **02.5** asked students to 'Explain'. In both cases 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 or number formation is poor, examiners make every effort to read what is written, but some answers can be very difficult to read.

Levels of demand

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

- **Standard demand** questions (aimed at grades 4–5)
- **Standard / high demand** questions (aimed at grades 6–7)
- **High demand** questions (aimed at grades 8–9).

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 (standard demand)

01.1 83% of students achieved this mark. None of the other three possible answers proved to be dominant.

01.2 79% of students achieved this mark. ‘The fractions have different melting points’ proved to be dominant wrong answer.

01.3 49% of students gained credit, recognising the alkane to be propane. Most popular incorrect answer was butane. Some students gave a formula even though the question asked for the name of the alkane.

01.4 The correct answer of C_nH_{2n+2} was the most commonly selected response by students (77%) although C_nH_{2n} proved to be the most effective distractor.

01.5 56% of students successfully balanced equation for the combustion of methane. Multiples were regularly seen, and credit accordingly given.

01.6 The correct answer of bromine water was chosen by 67% of students. Anhydrous copper sulfate proved to be the most effective distractor.

01.7 28% of students knew the definition from the specification or were able to give an equivalent statement. A large number of vague incorrect responses were seen encompassing issues such as pollution, sustainability, energy and carbon footprint.

01.8 In this 'extended response' question students were asked to compare the two methods for the disposal of biodegradable plastic bags using information given in Table 1.

26% of students gained full marks on this question and a further 38% of students achieved marks at level 2. 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.

17% 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 1.

The least creditworthy responses discussed in general terms the effect on the environment of burning waste plastic or the benefits of burning plastic bags to generate electricity. Students writing these responses made little reference to the information in Table 1 and many of these students ignored the key command word, 'Compare'. However, the higher-attaining students had logically worked their way down the information in Table 1, comparing and calculating differences when constructing their answer.

Question 2 (standard demand)

02.1 Methane was recognised by 85% of students as a greenhouse gas. Nitrogen was the most commonly seen incorrect response.

02.2 60% of students were able to name two effects of climate change, with a further 29% of students able to name one effect. Students give a wide range of creditworthy responses; melting polar ice caps, named extremes of weather and / or desertification.

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.

02.3 51% of students achieved some credit on this question. Many of those who knew the correct method failed to convert from grams to kilograms and consequently achieved only one mark for the calculation. The remainder of students attempted a single division or multiplication with two of the numbers given but were unable to continue to complete the calculation required.

Some students were able to apply the correct method, but did the calculation in two parts, and their rounding after the initial calculation gave rise to an incorrect final answer. Students should be aware that they should not undertake any rounding until they reach their final answer.

02.4 27% of students suggested using less plastic or recycled plastic in the manufacture of plastic bottles or gave a reference to carbon capture. Some incorrect responses focussed on the disposal, including burning plastic, rather than the manufacture of plastic or transportation of the plastic bottles, releasing carbon dioxide in to the air. Planting trees to capture the carbon or using renewable energy sources to provide energy for manufacturing the bottles proved popular ideas.

02.5 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.

19% 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. Many students gave detailed responses that showed a greater depth and understanding, giving numerous linked explanations for the changes in composition of the gases in the Earth's atmosphere. The most logically sequenced of these discussed each of the three gases in turn, resulting in very readable and accessible accounts. 33% of students achieved a level 2 mark, and a further 27% achieved a level 1 mark.

However, many of the lower-attaining students discussed post Industrial Revolution changes to the Earth's atmosphere, rather than addressing the changes since the formation of the Earth's early atmosphere. These students attempted to explain increases in carbon dioxide levels due to industrial manufacturing or other human activity; decreases in oxygen due to increasing population or deforestation. Some of these accounts were less logically sequenced and suggest that lower-attaining students are 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 formation of the Earth's early atmosphere but were not successful at linking these changes to explanations. The most popular explanation was the effects of photosynthesis on changes in the percentages of both oxygen and carbon dioxide. The dissolving of carbon dioxide into the newly formed oceans was better known than those of the volcanic action on the change in percentage of nitrogen.

Question 3 (standard & standard / high demand)

03.1 76% of students correctly calculated the mass as 16. Some students incorrectly calculated the mass to be 14.

03.2 56% of students achieved at least one mark; 16% achieved both. Incorrect responses describing the length of time 'for the solids to dissolve' were regularly seen. Marks were awarded more often for students who correctly gave a disadvantage of using a larger volume of water than those who attempted to give an advantaged by creating a list of reasons, for example reliable, accurate and precise.

03.3 27% of students correctly described the difference between pure water and potable water. 'Dissolved' was omitted from the majority of descriptions about potable water having chemicals, minerals or even vitamins and nutrients 'in it'. A number of students answered in terms of the pH of the two waters.

03.4 70% of students achieved at least one on this question. 25% gave responses that gained either all three marks or two marks. Students failed to separate out their answers highlighting the differences in the treatment methods to produce potable water from ground water and seawater. 'The water' was filtered, sterilised and distilled to produce potable water was a common response. The higher-attaining students gave clear, succinct responses using the correct terminology.

03.5 56% of students achieved full marks on this question. The most common mistake was not converting 2.2 into a percentage (0.022 or 2.2 ÷ 100) when multiplying by 6.50 to calculate the mass of dissolved solids.

Question 4 (standard, standard / high & high demand)

04.1 22% of students knew the definition from the specification or were able to give an equivalent statement. Often students mentioned only that it was ‘a mixture or chemicals mixed together’ but omitted the idea of ‘to form a useful product’. Some students were able to give examples, but not a definition.

As the question stem mentioned fertilisers, a few students answered the question with phrases such as a substance / something to help plants grow or to enhance plant growth.

04.2 5% of students achieved full marks but many students (63%) gained some credit for their calculation. The most common answers that achieved two marks were 0.18 or 0.1815, (not converting 14.52 kg to g and an omission or incorrect conversion of their calculation into standard form to two significant figures).

An answer of 1.8×10^{-1} achieved three marks, the calculation being correct, but the students had not undertaken the initial conversion of kg into g. Several students had multiplied an answer within their calculation by Avogadro’s number.

04.3 51% of students achieved some credit on this question. However, there were many references to intermolecular forces (often strong intermolecular forces), covalent bonds and molecules, all of which limited the response to a maximum of two marks.

Many students described in detail how potassium, being in Group 1 of the periodic table would transfer one electron to chlorine which is in Group 7 to obtain full outer shells meaning that the compound would have a high melting point. ‘Ionic bonds’ was often seen but normally as part of a lengthy explanation of how and why potassium transfers one electron to chlorine.

1% of students achieved full marks, with 7% of students achieving three marks; the description of a ‘lattice’ or ‘giant structure’ was seldom seen.

Question 5 (standard, standard / high & high demand)

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05.1 9% of students managed to correctly complete and balance the equation. Many different errors were seen. Students found it difficult to write the correct formulae of the products, for example, calcium chloride (CaCl), carbon dioxide (CO_3) and hydrogen (H_2) instead of water, but H_2 was probably written to balance the extra oxygen attributed to carbon dioxide.

Some students wrote down random products including ones with none of the elements present in the reactants. A sizeable minority of students simply repeated the reactants on the products side. Those students who did get the formulae of the products correct were usually able to balance the equation.

05.2 This question discriminated well with only 6% of students failing to achieve any marks for their answer. Most students quoted values (times and / or volumes) when describing the trend shown in the graph. Usually for the volume increase and the point at which the reaction stopped; as a result 53% of the students achieved two marks.

Many students failed to include in their answer that the rate slowed down. Three marks were awarded to 26% of students. Lower-attaining students simply described the shape of the graph without reference to any values.

05.3 Many students described drawing a line up from the *x*-axis to the curve and then another line across to the *y*-axis to read off the value which was not creditworthy. Several students mistakenly described how to calculate average rate of reaction.

24% of students correctly drew a tangent and explained how to work out the gradient. However, a few students incorrectly quoted y/x rather than $\Delta y/\Delta x$.

05.4 69% of students gave the correct answer of cm^3/s on this question. Nearly all other incorrect variations, for example cm/s, s/cm^3 and cm/sec were seen.

05.5 67% of students gained credit for a correct response. Although, many responses were confused; students stated that ‘a larger chip would have a faster rate of reaction because its surface area is bigger’. Some responses referred to how size of the marble chip affected the amount of gas produced, rather than the rate of its production.

05.6 29% of students achieved credit on this question. Many responses incorrectly stated that ’60 cm^3 was the maximum amount of gas that was in the chips’ or ‘it’s the maximum volume the syringe can hold’. Some students thought that both reactants had ‘been used up’. However, ‘a limiting factor’ was often seen as was ‘same mass of $CaCO_3$ used’.

05.7 54% of students achieved both marks for this question. Most students successfully calculated the surface area of one side of the large cube and then multiplied the answer by six (sides). An answer of 48 was regularly seen (volume of large cube × number of sides).

05.8 13% of students achieved both marks for this question. Many students were unable to correctly link the surface area to the size of the marble chips. Students often answered in terms of 'more collisions' with no reference to the frequency of those collisions.

A sizable number of students seem to think it was the marble chips colliding. Or they answered in terms of number of chips available (smaller the chips – more available to react) rather than considering the size the chips relative to their surface area.

05.9 In this question 82% of students achieved some credit for their response. 14% of students achieved all three marks. Both marking pathways were equally represented. However, very often students would start to answer in terms of one concentration then repeat information in the converse form for the other concentration but gaining no further marks.

Volume of gas evolved, or rate of reaction were the most common points addressed in student responses. Responses that stated 'fewer acid particles' or as highlighted in question **05.8**, their effect on the 'frequency of collisions', were seen less often.

Question 6 (standard & high demand)

06.1 53% of students achieved credit on this question. The majority of those in their response omitted to write 'damp or moist' when describing the litmus paper test. Limewater was a popular incorrect answer.

06.2 34% of students achieved any credit on this question; with 5% of responses achieving both marks. The idea of a 'closed system' was the most popular creditworthy answer.

Students described a reversible reaction, explained that the reactants changed into the products and vice versa but rarely indicated that it was the rate of these reactions that was equal. Some students gave the confused answer that 'the rate that reactants are used up is equal to the rate that the products are formed'.

06.3 In this question and in questions **06.4** and **06.5**, it was apparent that, although many students could recall Le Chatelier's Principle, few were able to apply it.

23% of students achieved more than one mark on this question, with 2% of students achieving all four marks. Students (34% that achieved one mark) were able to suggest a shift in the equilibrium but often in the wrong direction: 'The equilibrium shifts to the left so that more NaClO can be formed to react with the HCl'.

Some students gave responses that discussed changes in terms of the exothermic or endothermic direction though this was not given in the stem of the question.

A simple response that 'reaction would do the opposite' because of Le Chatelier was frequently given. Very few students concluded their explanation with 'a new equilibrium would be established'.

06.4 Many students answered incorrectly by explaining the effect of temperature on the rate of reaction rather than on the equilibrium. 8% of students achieved both marks. And a further 28% achieved a single mark, predominately for identifying that the amount of chlorine gas increased. 14% of students made no attempt at this question.

06.5 This was a challenging question whereby 7% of students achieved any marks. Many students answered incorrectly by explaining the effect of pressure on the rate of reaction rather than on the equilibrium. Those that answered with reference to the number of molecules on each side of the equation seemed to think that 2HCl was one molecule and consequently talked of the equilibrium shifting to the left, the side with fewer molecules. Approximately 12% of students made no attempt at this question.

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.