GCSE
COMBINED SCIENCE: TRILOGY

8464/C/1H
Report on the Examination

8464
June 2018

Version: 1.1

General

There were eight questions on this paper. Questions 1–3 were common to the Foundation Tier and were targeted at grades 4–5. Students should be prepared to expect that they will be given unfamiliar contexts and information that assess the Assessment Objectives. Familiar contexts are those mentioned in the specification and assess recall, selection and communication of students' knowledge and understanding. Most students started the paper well but were finding it difficult to gain credit by the time they reached the last questions which were more demanding.

There were some common misinterpretations of questions due either to lack of familiarity with common scientific terms such as 'electronic structure', 'formula', 'molten'' or 'liquid' and 'stoichiometry' which students will be expected to understand. Students need to be able to identify the key words in questions such as 'describe' and 'explain'. Other problems in interpretation arose as students had not always read the question carefully enough to grasp what was being asked.

The majority of students appeared to have sufficient time to complete the paper. This paper was more demanding than legacy specifications and tested a wider range of mathematical skills; many students did not know how to attempt the reacting mass calculation. This produced a good degree of differentiation amongst students with a wide spread of marks. There were plenty of opportunities for higher-attaining students to demonstrate their knowledge. There appeared to be a significant number of students who may have been more suited to the Foundation Tier.

A few students used up a lot of space by repeating the question, which does not gain students any credit. There were a number of students whose scripts were difficult to read, either due to poor handwriting or the use of pens with other than black ink, or both.

Students were generally good at fitting their answers into the space available, but a number of students used additional pages for working purposes which needs to be crossed out or to write a few words, which would have fitted on to the original paper. Students need to understand the list principle. If they give two answers (one right and one wrong) when only one is required then no mark can be awarded.

Basic knowledge and understanding in familiar and in unfamiliar situations, including in the laboratory, are tested throughout this paper. This means that it is essential that students read and analyse the information provided, then read and understand the question before writing their response. Students should then check their answers, especially those that are descriptions or explanations. Many students use 'it' or 'they' without any clear indication of what the student is referring to.

Student performance would benefit from good memory of the symbols, common substances and formulae of ions and their use in making formulae need more attention. They need to learn the different types of bonding in elements and compounds.

Levels of demand

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

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard / high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target 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 Halogens are produced at the positive electrode if the solution contains a halide ion. 51% of students correctly selected chlorine as the gas produced.

01.2 Students could have linked their knowledge of the reactivity series, with which ion is discharged when an aqueous solution is electrolysed. In this case, the production of copper at the negative electrode informs students that copper is less reactive than hydrogen. 46% of students were able to correctly deduce this.

01.3 Students needed to look at the data and see that the mass produced at three minutes was missing from the table. Experimental errors account for the trend not being exactly directly proportional. In this instance 63% of students noticed the relationship and correctly deduced the mass. The mark scheme did allow a small range around the expected answer.

01.4 68% of students achieved full marks for this question giving an answer of 3.15 (mg), however, a significant number did so without showing their working. This was not an issue where they obtained the correct answer, but some didn't and therefore gained no credit as it was not possible to see how they had obtained their answer.

A working mark was available and showing 9.18 (mg) was the most likely way that this was gained by students.

01.5 A unit conversion between cm^3 and dm^3 in this question requires a division of either:

- 50 by 1000 to convert cm^3 to dm^3 or
- 300 by 1000 to convert mass per dm^3 to mass per cm^3

This conversion is essential to make progress in this calculation. 14% of students understood this concept and achieved the maximum three marks for this question.

A significant number either divided 300 by 50 with an answer of 6 or multiplied 300 by 50. The latter led to a compensatory mark for 15 000.

Question 2 (standard demand)

02.1 73% of students achieved at least a mark on this question. Many could clearly see the most obvious difference and similarity in the electronic structures of sodium and chlorine. These correct answers were described in a variety ways eg different number of electrons or by stating the correct number of electrons in the outer shell. Examples of similarities related to the number of shells or completed inner energy levels.

Students often used the periodic table shown in the stem of the question to answer the question, but most of these referred to periods and groups and failed to gain marks. Students should note that there is only one ‘outer’ shell or level.

02.2 This question was well answered with 63% of students achieving all four marks, often with concise statements.

Some students contradicted their description by mentioning covalent, the incorrect type of bonding, or the sharing of electrons, which restricted the number of marks they could attain.

Students need to use scientific terminology accurately. Ionic bonding occurs when a metal transfers its electron(s) to a non-metal (loss and gain of electrons). Whereas covalent bonding involves non-metals sharing electrons, which results in the formation of covalent bonds.

02.3 67% of students achieved both marks, although it was common for students to have incomplete diagrams, by failing to include a horizontal for the products side. Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams.

Question 3 (standard demand)

03 This was an ‘extended response question’ that was based around Required Practical Activity 8. The quality of responses ranged from near perfect plans that achieved six marks to those which merely repeated the stem of the question and gained zero.

The question stated that the method contains several errors and does not produce copper sulfate crystals. It was quite common for students to miss that the wrong two chemicals were being used in the question stem. And although some students could see that a copper compound needed to be used, they didn’t recognise that sulfuric acid would be needed to produce a sulfate.

Common improvements that gained no credit included quoting volume and masses, while some responses just changed the apparatus, or expanded the method and still included the errors.

In many cases students mentioned an improvement but failed to explain the reason for the change. For example, many students:

- mentioned the need to filter but failed to state that filtering removed the excess copper carbonate
- stated that excess base was added but did not justify that this was to ensure all the acid was neutralised.

This question discriminated between students well with 31% of students achieving a level 2 or 3 mark. Students generally found it tough, with 2% achieved full marks, and 22% of gaining no credit.

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

04.1 Students did not answer this question as well as expected. They were either not aware that chlorine was a gas or were not familiar with state symbols, as answers other than (s), (l) (g) or (aq) were frequently seen. Some wrote the word 'gas' in the space. 36% of students answered correctly.

04.2 This question was very well answered with 64% of students achieving full marks. Students showed a good understanding of the number of electrons involved in this example of covalent bonding, by ensuring that they had two electrons in the overlap area and six other electrons in the energy level of each fluorine.

A common mistake was to include two electrons in the overlap, but still included the seven electrons each fluorine originally contained in the level outside the overlap.

04.3 48% of students selected the correct answer to this question. The question followed the diagram of a fluorine (F_2) molecule in question **04.2** and focussed on this species.

A significant number of students incorrectly selected '9' as their response, which is the number of electrons in one fluorine atom.

04.4 Students are expected to represent the electronic structures of the first 20 elements of the periodic table and to predict and explain reactions of elements from their position in the periodic table.

A small number of students were able to state the correct formula, $AlBr_3$, with AlBr and $AlBr_2$ being the most common incorrect formulae. But, students did show a good understanding of balancing equations, in this case based upon their wrong formula for aluminium bromide. 68% of students achieved a single mark.

04.5 This question was not answered well, with 8% of students achieving three marks for the explanation that included:

- comparative size of atoms
- comparative difference in attraction
- the ease of which an electron was gained.

This last point was the one that was seen the least and the word 'outer' (shell or level) was omitted in a lot of answers.

Often students would repeat the question stem in terms of chlorine and bromine's reactivity without relating it to the whole of Group 7 and in many instances referring to the reactivity series (of metals).

Question 5 (standard / high & high demand)

05.1 The question was well attempted with 80% of students achieving at least one mark. The marks awarded were fairly evenly distributed between the three marking points.

Students rarely achieved full marks (14%), often because they confused the type of particles or bonding involved. While many could identify that covalent bonds were used and lots of energy was needed to break these bonds, they found it difficult to describe the structure involved.

A common response was that diamond contains four carbon atoms rather than each carbon atom having four bonds, which would have been sufficient to be awarded the second marking point.

05.2 The diagram showed a structure made up of ions. These have to be free moving to conduct electricity.

7% of students achieved full marks. Generally students missed out on full marks because they only included one way to produce ions, dissolving or melting. There was confusion among students between the terms liquid and solution. Many said that sodium chloride needs to be ‘molten’ or ‘liquid’, presumably often meaning molten or dissolved (in water).

The most common mistake in responses was that students thought that electrons were involved in the conduction of electricity in this situation.

05.3 49% of students achieved at least one mark, usually for marking points one or two. Higher attaining-students frequently achieved two marks for ‘delocalised electrons free to move’.

Marking point three was rare and was often poorly expressed. Lots of responses repeated the question stem with phrases such as ‘so it conducts thermal energy’ or ‘thermal energy passes between the particles’. Very few students mentioned energy being transferred. A common statement was that ‘delocalised electrons carry electric charge’ but not (thermal) energy.

Question 6 (standard, standard / high & high demand)

06.1 The question was not answered well, with large numbers of students missing the key word 'formula' in the question stem. As a result, lots of responses included the names of a wide range of chemicals. Quite a few knew the formula for carbon dioxide.

06.2 Those students who were aware that carbonate had a formula of CO_3 usually came up with the correct answer. Many opted for more well-known Group 2 carbonates such as calcium and magnesium, usually with little justification.

06.3 A good number of students could successfully calculate the gradient. Most students knew the method but could not get the correct figures from the graph. Students seemed to make their life very difficult when selecting values from the graph to calculate the gradient.

The easiest methods would have been to:

- use the increase in mass from 0 g to 1 g, with the equivalent volume increase of 167 cm^3, to give a simple calculation of 167 ÷ 1
- increase in mass from 0 g to 0.5 g, or 0 g to 2 g would have also given relatively easy calculations.

There were very few inverted equations but very few correct units, these were invariably inverted as g/cm^3

When determining a gradient students should be encouraged to draw the sides of their triangle as large as possible, as this reduces the error in reading the *x* and *y* values from the graph.

06.4 This question was answered well by only the highest-attaining students with 4% achieving full marks. Their working followed those methods in the mark scheme or routes based upon these, which also achieved full credit. These students could either see the link from the graph, where 240 cm^3 had a mass of 1.45 g, and the subsequent conversion from 240 cm^3 to 24 dm^3 or they divided the volume (in cm^3) by their gradient.

Some students used a volume on the *y*-axis of 24 cm^3, which gave a mass of approximately 0.15 g on the *x*-axis, which scaled up to (a correct answer of) 150. However, because their scale was so small, some got the mass as 0.16 g. As this is within half a small square and scaled up to 160, these students were also awarded full credit.

Students should be aware that when larger values are taken from the *x* and *y*-axes, errors in subsequent calculations are minimised.

Question 7 (standard / high & high demand)

07.1 In this 'extended response' question many students used the information effectively and gave very good explanations. 73% of students were able to achieve at least one mark, while 18% of students gave answers sufficient enough to meet the demands of the level 3 descriptor.

Some misunderstood the solubility data and gave SiO_2 as the most soluble. Many understood how pH related to acid, alkali and neutral. Although a common error was the confusion between whether sodium oxide was alkaline or acidic so many gave C and D correct from the solubility data but A and B incorrect.

In long descriptions, students would often contradict chemical identification or properties due to a lack of organisation within their response. A number gave the identity of the substances as elements instead of oxides. Some did not link the letters with any of the four substances listed in the question, choosing others compounds.

07.2 Students struggled with the concept that is if an acid is diluted by a factor of 10 then the pH increases by 1. Very few showed any attempt at the correct method, with 12% of students achieving one or two marks. Most students simply multiplied the 3 by 100 to give an answer of 300.

Question 8 (standard, standard / high & high demand)

08.1 66% of students answered this question correctly. The most common incorrect answer was water.

08.2 47% of students appreciated the need for filtration or the use of a magnet. The most common incorrect responses were electrolysis, distillation, heating / evaporation or displacement using carbon.

Students need to understand the list principle. If they give two answers (one correct and one incorrect) when only one is required, no mark can be awarded. This was the case with those students who gave filter and another method that was incorrect eg simple distillation.

08.3 Students found this question tough, but it discriminated well with higher-attaining students being able to achieve four or five marks (10%). 74% of students scored zero marks.

The most common mistake found in correct calculation methods was the absence of a conversion from g to mg. Some got to 0.185 g and then stopped or converted g to mg incorrectly. Common errors were dividing by 1000 rather than multiplying by 1000 or using a factor of 10 or 100 to convert g to mg.

Stoichiometry was not well understood which resulted in students obtaining an answers of:

- 280 mg or 0.280 g due to the omission of the stoichiometric ratio (× 2/3) or
- 124 mg or 0.124 g where they had divided by 72 and multiplied by 112, and had multiplied by 2/3 as well, so they had taken the ratio into account twice.

Some students got as far as 0.12/24 or 0.12/72 and then no further. Others tried to calculate RFMs for the compounds involved and got no further and gained no marks.

08.4 The most common mark achieved was for stating that reduction was the gaining of electrons. Many students quoted OILRIG but gave an incomplete answer of 'reduction was gain', without stating what it was that was being gained.

Few students specifically identified the 'reduced species' being reduced. Some did identify iron was reduced but didn't say which ion of iron, others gave magnesium or iron chloride.

Only a small number of students correctly wrote the half equation. 1% of students achieved two or three marks.

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.