GCSE

COMBINED SCIENCE: TRILOGY

8464/C/1H: Paper 1 Chemistry Higher
Report on the Examination

8464
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General

This was the second session for this reformed specification, which is assessed by two terminal examinations in each science. This paper was out of seventy marks and the students had 75 minutes in which to complete it. There were six questions on this paper. Questions one and two were common to Foundation and Higher Tiers and were targeted at standard demand.

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. This produced a good degree of differentiation amongst students with a wide spread of marks. The majority of students appeared to have sufficient time to complete the paper.

There are three assessment objectives. Approximately 40% of the marks on the paper are for demonstrating knowledge and understanding of: scientific ideas, scientific techniques and procedures (AO1), another 40% on application of knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures (AO2) and approximately 20% for analysing information and ideas to: interpret and evaluate; make judgements and draw conclusions; develop and improve experimental procedures (AO3).

Students should be prepared to expect that they will be given unfamiliar contexts and information that assess these objectives. Familiar contexts are those mentioned in the specification and assess recall, selection and communication of students' knowledge and understanding. The mark scheme was designed to allow students to gain marks for showing knowledge, understanding and application of chemistry. 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.

There were some common misinterpretations of questions due either to lack of familiarity with common scientific terms such as 'electronic structure', 'formula' and 'molten' or 'liquid' which Higher Tier students will be expected to understand. Students need to read and pick out the key (command) words in questions such as describe and explain.

A few students used up a lot of space by repeating the question, which really is not needed in these examinations as it does not gain them 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.

Two of the questions focused on two of the Required Practical Activities, 9 and 10.

This report should be read in conjunction with the published mark scheme.

Levels of demand

Questions are set at four levels of demand for this specification with different levels of demand within each of the tiers.

There are 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 is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level they are working at.

Question 1

This question was common with the Foundation paper and each item was at standard demand.

01.1 The decreasing reactivity of the metals was deduced from the amount of effervescence in each reaction. Most students selected the correct order.

01.2 Although most students had a good understanding of the control variables in this situation, the way they described the variable sometimes lacked the correct terminology. 'Amount of acid' was often used instead of 'volume of acid'.

01.3 This question to identify the independent variable was well answered, although it was common to see other incorrect variables mentioned, such as reactivity of the metals or number of bubbles.

01.4 This question comparing the reactivity of beryllium to magnesium was reasonably well answered. A number of students gained no credit as they stated that beryllium was more reactive. Some students stated that magnesium has more 'outer shells'; all elements only have one outer shell. Trends in reactivity had to refer to the group (as the question stated to use the periodic table) and not the periodic table or reactivity series. The word 'outer' was frequently omitted, so responses such as the electrons in magnesium are further from the nucleus were insufficient.

01.5 A quarter of students used a variety of methods to correctly calculate the concentration. Just under a half of the students scored 2 of the 3 marks, usually failing to correctly convert cm^3 to dm^3

Question 2

This question was common with the Foundation paper and included an extended response question based around Required Practical Activity 10. Each item was at standard demand.

02.1 This question was poorly answered where only a quarter of students gained the mark. A wide range of incorrect responses were seen. Many students wrote a chemical formula of ammonium nitrate instead of the state symbol. Students should know that state symbols are lower case only which are written in brackets.

02.2 Around two-thirds of students identified the correct formula of nitric acid. The next most common response was the alkali NH_4OH

02.3 This recall question was generally well answered with more than half the students gaining both marks. Two colours were often listed eg red/orange or blue/purple when only one colour was required. The most common incorrect responses included green, black and colourless.

02.4 Approximately one-third of students identified the correct pH change when nitric acid was added to ammonia solution. The three incorrect responses were selected in approximately equal amounts. A large number of students did not follow the rubric of the question which required them to tick one box only.

02.5 This question discriminated well. Two-thirds of students gained all three marks for an answer of 60%. A very common error was to carry out the calculation for only one oxygen atom, leading to an answer of 20%, which gained two marks. Some students started the calculation correctly by calculating 48 for three oxygen atoms, but then subtracted that from the given relative formula mass to give 32, which was then used in a percentage calculation.

02.6 Most students had a good understanding of the requirements of this question which was based upon Required Practical Activity 10. They could appreciate the need to control variables, although the most common errors were to not mention a constant volume of water when starting each experiment or not taking the temperature of the water before the ammonium nitrate was added. The descriptions were often poorly organised with statements relating to a constant volume of water or measuring the starting temperature appearing at the end of the response. Some students carried out the experiment in one container, adding successive masses to the same beaker in the same way they could have done a heat of neutralisation experiment. This question discriminated well with approximately a fifth of students achieving level 3 and a half achieving level 2.

Question 3

This was the first question not common with the Foundation tier. There was a ramping of demand through the question from standard demand (03.1) to standard/high demand (03.2) then to high demand (03.3 and 03.4).

03.1 A good proportion of students correctly identified the activation energy. Common errors included arrows pointing to the maximum of the energy diagram or to a section of the line leading to the peak.

03.2 Students were very good at determining the overall energy change; nearly three-quarters of all students gained full marks. Those students who selected one value of either the reactants or products from the graph gained credit for a correct subtraction of their values.

03.3 Students provided a wide range of responses for the dot-and-cross diagram of oxygen. Half of all students appreciated the number of electrons involved in bonding and non-bonding. A number of students did not appreciate that oxygen always has two sharing pairs of electrons; in this case a double bond results between the two atoms. Others who added 4 electrons for a double bond often still added 3 other non-bonding pairs on each O atom.

03.4 This question discriminated very well where two-fifths of students gained all three marks for an answer of (–) 220 kJ.

Many students presented their working clearly. This allowed examiners to identify where any errors had been made which allowed access to the final marking point (MP3); a subtraction of bonds made (their MP2) from bonds broken (their MP1).

Common mistakes centred on using an O-O value when an O=O bond strength should have been used and not taking into account the stoichiometry of the equation.

Question 4

Most of this question was at standard/high demand.

04.1 Scientists' use of atomic weight to arrange elements in early periodic tables was not well known. Far too many students did not fully appreciate the historical nature of the question and provided concepts that were not known at the time, such as atomic number and electrons.

04.2 Over half the entry gave a correct reason. Large numbers of students appreciated that Mendeleev left gaps or grouped elements with similar properties. Changing the order based upon atomic weights was correct but less common.

04.3 Only the higher-attaining students were able to explain that halogens have low boiling points because of weak intermolecular forces. It is these forces that are overcome when a 'little energy' is applied; less energy did not gain this mark, as less does not necessarily equate to little. Many students answered this question incorrectly in terms of the covalent bonds within the halogens. A lot of students linked the listed values to reactivity within group 7.

04.4 The concept of intermolecular forces and the fact that the intermolecular forces increase because the molecules got larger was rarely seen in explanations. Many students gained a mark for stating that the boiling points increased down the group; down the table or periodic table did not gain this mark. Students commonly tried to explain a trend in reactivity down the group and attempted to link that to boiling points. Some struggled with negative temperatures.

04.5 Most students were able to state that neon's outer shell was full. Many did not gain the second mark by not giving the electronic structure of neon.

04.6 A third of students calculated the correct answer for 2 marks. Many were confused by standard form, with only a few students making slight calculation errors.
Most wrong answers came from either dividing the Avogadro number by 0.025 (the number of moles) or from multiplying by 40; they did not appreciate that 1g of argon is less than 1 mole of argon so the answer to this question must be less than 6×10^{23}

Question 5

As well as an increase in demand through each question in the paper, there was a ramping of demand in this question from standard/high demand to high demand.

05.1 A fifth of students were able to give the reason that electrolysis was used when a metal was more reactive than carbon. Many answers were too vague in terms of metals being reactive, rather than including the comparison with carbon. It was very rare to see a response showing that a student knew that some metals might react with carbon.

05.2 Students found this question challenging. Cryolite was usually the answer that gained one mark. Very few students gave two-mark answers. The most common incorrect responses mentioned a wide variety of elements including the products of electrolysis 'aluminium' and 'oxygen'.

05.3 This high demand question discriminated very well. Students should recognise that electrons are negatively charged. To balance 'charges', electrons need to be added as a reactant in the first equation and are produced as a product in the second; the negative charge on the electron must be shown. The first equation was more successfully attempted than the second. Symbols should always have the second letter as lower case.

05.4 Many students answered for a standard yield type question without considering the circumstances of the experiment. Common non-creditworthy responses included:

- not all reacted
- some lost as a gas
- unexpected products formed.

Many thought the electrode being made from copper would affect the mass measured. A number questioned the power supply without specifying voltage or current.

05.5 This question was very well answered with more than two-thirds of students scoring all 3 marks. There were 2 common approaches to this question. Many students read the mass and scaled up. A mass of 5.4g at 30 minutes was a common starting point, which resulted in an answer of 259 mg. A tolerance was allowed reading the graph which led to a range of results, which was narrower at longer initial times. Others calculated the gradient (0.18) and then used this value to determine the mass after 24 hours. Students used many variations of both methods to obtain a valid and correct answer. A common error was to misread the graph (e.g. mass of 5.2 g at 30 minutes); 2 of the remaining 3 marks were awarded for a subsequent correct evaluation.

05.6 Over three-quarters of students were able to determine the mass of the electrode from the graph.

05.7 This question was well answered and discriminated well. The increases in Y and X were usually calculated correctly. However, a small number of students then inverted the values when calculating the gradient. Some did not evaluate the calculation giving an answer for the gradient as 1/5 for example. The unit mark was generally correct.

Question 6

This question was mostly high demand.

06.1 Approximately one-third of students identified the balanced equation for the reaction. The first two responses proved to be good distractors.

06.2 A large proportion of students failed to gain any marks on this question. Students need to ensure they consider the command words at the beginning of questions; many described how sodium reacted with chlorine in terms of electron transfer. Very few described what they would actually see. Some students answered the 'before section' by stating that nothing happened. Few students stated chlorine was a green gas or sodium a silvery metal. For marking point 2 students often mentioned the rate of the reaction and formation of gas rather than considering actual observations. The most common observation mentioned in this section was fizzing. It gave the impression with other comments that students were talking about the reaction between sodium and water. For marking point 3 many students described cloudiness, without identifying that a white solid was involved.

06.3 This question achieved a spread of marks and discriminated very well. 'More outer shells' and references to intermolecular forces were often seen; only molecules can have intermolecular forces. References to potassium 'having a higher melting or boiling point' or 'bigger atomic mass or atomic number' were also given as reasons for it being more reactive; these answers displayed confusion in the difference between chemical and physical properties.

There were many vague statements about the trend in reactivity down Group 1, but these did not gain any credit. Students often made statements about electrons and shells but did not specifically mention electrons in the <u>outer</u> shell. Many students understood that there was a force holding the outer shell electron, but it was a common error to not mention the nucleus or that it was a force of attraction. Those students who mentioned that there was a force of attraction often omitted to mention that it decreased down the group. Marking point 4 was the most commonly awarded mark, with students explaining the ease of losing an electron in terms of sodium and potassium.

06.4 This question discriminated very well with only the most able students accessing level 2. Students had an excellent understanding of bonding, covering types of bonding, transfer or sharing of electrons, full shell stability and ion formation. However, the question asked for information on bonding <u>and</u> structure for sodium chloride <u>and</u> hydrogen chloride. Only a small proportion included comments about the structure, and even fewer made comments that compared the magnitude of forces/bonding within both substances.

Many responses had incorrect or vague statements. Although many students understood the formation of sodium and chloride ions, very few appeared to appreciate the consequence of this in the formation of an ionic lattice. Some students stated both sodium chloride and hydrogen chloride had the same type of bonding. There was also a lot of confusion over types of bonding and forces, with students often contradicting themselves during their response.

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.