AQA

GCSE
COMBINED SCIENCE: TRILOGY

8464/C/1H: Paper 1 – Chemistry (Higher tier)
Report on the Examination

8464
June 2022

Version: 1.0

General

Questions one, two and three were common to Foundation and Higher tiers and were targeted at standard demand.

Students should be prepared to expect that they will be given unfamiliar contexts and information. 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.

Three of the questions focused on the Required Practical Activities, 8, 9 and 10.

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

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 Students were asked to state observations when copper carbonate is added to sulfuric acid. 30% of students gave at least two correct observations. The most common responses were 'colour changes' or 'fizzing'. Many students appeared to misunderstand what an observation is and instead either wrote instructions on how to carry out the preparation of copper sulfate or gave vague comments such as 'there was a reaction', or 'it stopped reacting', along with describing the reaction with comments such as carbon dioxide gas was given off. Some students referred to copper carbonate as either copper or copper oxide which are different chemicals.

01.2 Nearly three quarters of students knew that filtration is used to separate unreacted copper carbonate after a reaction between sulfuric acid and excess copper carbonate.

01.3 Just under half the students knew the pH of the solution at the end of the reaction between sulfuric acid and excess copper carbonate.

01.4 Just over a third of students knew that the reaction between sulfuric acid and copper carbonate was neutralisation.

01.5 The question required students to read the masses of ammonium nitrate that dissolve at 80 °C and 20 °C from a graph and to then carry out a subtraction to determine the mass of solid that crystallises on cooling. Just over 40% of students were able to gain all 3 marks. There were a minority of students who failed to show any working except for small crosses on the graph.

Question 2 (Standard demand)

02.1 Students were given the formula of the potassium and sulfate ions and asked to deduce the formula of potassium sulfate. Just over 50% of students correctly determined the formula as K_2SO_4. The formulae KSO_4 and $K(SO_4)_2$ proved to be good distractors.

02.2 Just over 45% of students were able to correctly read the volumes of hydrogen and oxygen in the measuring cylinders. Many wrote the volumes of solution left in the measuring cylinder rather than the gas, stating 20 cm^3 for hydrogen and 35 cm^3 for oxygen.

02.3 This question was a good discriminator. A third of students answered this correctly. Students were given a hypothesis linking the ratio of the volumes of gases collected in an electrolysis experiment with the ratio of hydrogen to oxygen atoms in a water molecule. When students deduced that the volumes of hydrogen gas and oxygen gas collected were 30 cm^3 and 15 cm^3, they were able to simplify this ratio to 2:1 which they recognised as the ratio of hydrogen atoms to oxygen atoms in a water molecule and were thus able to confirm the hypothesis. When the ratio of their volumes was not 2:1 many lacked the confidence to state that the hypothesis was incorrect.

02.4 Just over 40% of students identified that the measure of uncertainty in the 4 experiments was 9 ± 3 cm^3. The mean volume was 9 cm^3 and the range of reading was from 6 to 11 cm^3. The option of 9 ± 2 cm^3 proved to be a good distractor.

02.5 A quarter of students gained all 3 marks with a similar number gaining 2 of the 3 marks available. The most common method was to divide the mass of 0.86 g by the volume of 25 cm^3. Some students then went onto carry out the unit conversion of cm^3 into dm^3 which required multiplying their answer (in g/cm^3) by 1000.There was still a small minority of students who showed no working at all.

Question 3 (Standard demand)

03 This question discriminated well with nearly 60% of students achieving level two or above. It was based upon Required Practical Activity 10. Students needed to plan an investigation to find the order of reactivity of three metals using the temperature change recorded when each metal reacts with hydrochloric acid.

To access level 3, the method would lead to a valid outcome. This required students controlling variables such as the mass of metal and the volume of acid reacting, determining a temperature change having recorded the initial and final temperatures and repeating the method for each metal.

To access level 2 the method would not necessarily lead to a valid outcome. Students were generally good at providing practical details. The main oversights that prevented a valid outcome were the measurement of starting temperature and/or controlling the mass of metal. Students should be encouraged to state volumes and masses as most creditworthy responses regarding the control of volume and mass did so by stating a value and then repeating with the other metals. Weaker responses gained credit for either correctly identifying apparatus or for explaining the link between expected results and the reactivity of the metal.

Question 4 (Standard, standard/high and high demand)

04.1 Approximately 70% of students could correctly identify Group 7 elements as the halogens.

04.2 Just over half of students stated that Group 7 elements react in similar ways because they all have 7 electrons in their outer shell. Many omitted the word outer which was a requirement for the mark.

04.3 Just under a third of students were able to deduce the molecular formula of Cl_2O_7 from the diagram of a molecule of a chlorine oxide. Students need to ensure that subscript numbers can be distinguished as such.

04.4 Nearly 70% students of students were able to gain both marks for completing the scale of the *y*-axis and drawing a bar at –220 °C for the melting point of fluorine. A significant minority failed to score the first marking point as the scale was not completed to minus 250 °C.

04.5 Very few students gained 3 marks. More than 60% gained 1 mark, usually for stating that the melting points increase going down Group 7. However students were unable to explain that this is because the molecules increase in size going down the group and the intermolecular forces increase, with only a small number of students gaining any further marks.

04.6 Just over 40% of the students deduced that bromine is a solid at –220 °C. Liquid proved to be a popular distractor.

04.7 Just under 40% of students knew that condensation happens at the surface of bromine at its boiling point.

Question 5 (Standard/high and high demand)

05.1 This question discriminated well with a third of students recognising the structure of a fullerene.

05.2 Students struggled to suggest a property of the fullerene molecule, with just over 30% gaining a mark.

05.3 More than half the students scored one mark or more in their explanation of why metals are added to aluminium to produce an alloy. However students found developing an explanation challenging. The most commonly awarded mark was for the alloy being harder or stronger. In some responses there was confusion about layers sliding over each other when many talked about ‘metals’ or ‘molecules’ rather than ‘atoms’. The marking point stating that atoms of other metals have different sizes was the least often awarded.

05.4 This question required students to use correct scientific terminology. This question discriminated well with 30% of students gaining at least one mark though many students seemed to know that the bonds in the chains were strong and between chains were weak, but they did not name them correctly and therefore failed to score.

Question 6 (Standard, standard/high and high demand)

06.1 Two third of students correctly drew a dot and cross diagram for hydrogen chloride. The most common mark was for the two shared electrons in the overlap between the atoms. Many did not show that there are six unshared electrons.

06.2 Less than 10% were able to state what is meant by the term strong acid. Many omitted 'in aqueous solution'.

06.3 40% of students gained 1 mark usually for referring to an observation when magnesium reacts with a strong acid and a weak acid. The second mark was for a comparison of the rates of reaction between magnesium and the two acids, with few students being able to develop their response to give this.

06.4 Nearly 40% of students gained 1 mark usually for stating that the pH decreases when the concentration was increased. However very few recognised that pH was related to the power of 10, so when the concentration of hydrochloric acid is increased by a factor of 100 then the pH will decrease by 2.

06.5 Many students were good at calculating the energy changes for bonds broken and bonds made, however then went on to simply subtract these two numbers without taking into account the C=C bond energy. Many students kept their working to a minimum which often did not help them score. This question discriminated well with better responses showing clear working where the energy released was equated to the difference between the bonds made and the bonds broken.

Question 7 (Standard/high and high demand)

07.1 Students had to recognise the relative position of a metal in a reactivity series and to deduce the method and conditions used to extract the metal from a compound of the metal. Over 50% of students gained 1 mark. Electrolysis was the most common answer. However, many students then went on to talk about electrolysis of a solution rather than the molten compound. The displacement route was less common and those who chose this method often only scored 1 mark as they failed to mention 'heating' when talking about potassium or magnesium.

07.2 Students had to complete an equation for the displacement reaction between sodium and titanium chloride. Some students were not able to identify the products. Titanium was usually identified, but sodium chloride was often written as $NaCl_4$. Without the correct formulae balancing was not possible. Generally, element symbols were written well with upper and lower case letters in the appropriate place. Nearly 20% of students gained both marks.

07.3 Students were asked to write the half equation to show the oxidation of sodium. This proved very challenging. Approximately 5% gained two marks with about a fifth of students not attempting the question. One mark was infrequently scored, since identifying the equation and not the balancing proved to be the problem.

07.4 This reacting mass calculation where students had to identify the limiting reagent proved very challenging. Only a small percentage of students were able to show that aluminium was the limiting factor. Although there were several methods available to students, many attempted to use more than one method to get to the answer. Many students could work out the number of moles of aluminium and copper chloride or the ratio of masses that reacted together, but then were unable to use these numbers further. 30% of students scored 3 marks in this calculation but few scored any further marks..

07.5 Students had to describe how sodium metal conducts electricity. More than 50% of students gained 1 mark for stating that delocalised electrons or free electrons were responsible for electrical conduction in metals. The idea that these delocalised electrons carry the charge through the metal was infrequently given (the second marking point). Many students suggested throughout or around, which did not give direction to their answer.

07.6 Students had to explain how sodium chloride conducts electricity. Many students gave the impression that sodium chloride is a liquid or (to a lesser extent) aqueous solution, rather than conveying that conductivity is restricted to when sodium choride is in these states. Many incorrectly described the electrons as the particles that were able to move. 10% of students gained all 3 marks for stating that sodium chloride needed to be either molten or in aqueous solution in order to conduct electricity and went on to mention ions that are free to move.

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.