GCSE

COMBINED SCIENCE: TRILOGY

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

8464/C/1H
June 2023

Version: 1.0

Further copies of this Report are available from aqa.org.uk

General Comments

Around 140,000 students sat this component, so a wide and varied range of responses was seen.

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 were some common misinterpretations of questions due to lack of familiarity with common scientific terms which Higher Tier students will be expected to understand. Common apparatus used in the laboratory should also be known. 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.

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.

There were seven questions on this paper. Questions 1and 2 were common to the Foundation Tier. The demand levels of the questions are designed to increase from standard demand to high demand through the paper. From question 3 onwards, the demand of each question also increases through the question. As expected, students generally had more difficulty gaining credit in the high demand questions towards the end of the paper. However, the vast majority of students attempted all the questions.

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.

Comments on Individual Questions

Question 1 (standard demand)

01.1 Students were asked to state which ion makes a solution acidic. 30% of students correctly identified the ion as H^+. Carbon was a very common incorrect response.

01.2 More than half the students named an indicator that could be used to test if a solution is acidic and most of these then gave the correct colour in the acid solution. The majority of students listed universal indicator.

01.3 More than three-quarters of students deduced that the solubility of carbon dioxide decreases as the temperature of water increases. The solubility increases proved to be the most common distractor.

01.4 Just over a third of students deduced that the pH of the solution increases as the temperature of water increases. More students selected the pH of the solution decreases.

01.5 More than three-quarters of students knew that the state symbol of water is (l). The most popular distractor was (aq).

01.6 This question proved accessible for the vast majority of students and discriminated well with over 80% of students achieving level two or above. Students needed to plan a method to investigate the volume of carbon dioxide produced when different masses of calcium carbonate react with hydrochloric acid. To access level 3, the method would lead to a valid outcome. To access level 2 the method would not necessarily lead to a valid outcome. Common reasons for students not accessing level 3 was the use of incorrectly named equipment or the use of a beaker to carry out the reaction as the gas syringe would not be able to be attached to a beaker so the gas could not be collected and measured. Details of when to read the gas syringe was the common omission. 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 repeated with other masses. Students working at level 1 usually gained credit for either mixing the reagents or attempting to collect and measure the gas produced.

Question 2 (standard demand)

02.1 More than a third of students knew that the reaction was either neutralisation or exothermic. Displacement and endothermic were common incorrect responses.

02.2 Over 80% of students correctly calculated the relative formula mass of sulfuric acid from the given formula.

02.3 This question was a good discriminator. Just under half of students answered this correctly. A further 20% gained 3 marks; either failing to recognise that there are four oxygen atoms in lithium sulphate or for not giving their answer to 2 significant figures.

02.4 This question was a good discriminator. A third of students gained all 3 marks. The most common method was to start by evaluating the mass of 0.30 g divided by the volume of 25 cm^3. A third of students failed to then carry out the unit conversion of cm^3 into dm^3.

Question 3 (standard, standard/high demand and high demand)

03.1 Nearly three-quarters of the students correctly balanced the equation for the reaction of sodium with oxygen to produce sodium oxide.

03.2 This question was a good discriminator. Most students understood the processes involved in this question, but poor use of chemical language meant they often did not achieve the marks. Students often referred to sodium and oxygen, rather than sodium atoms and oxygen atoms and many incorrect terms such as ‘atoms sharing electrons to form ionic bonds’, ‘metal ions losing electrons’ and ‘non-metal ions gaining electrons’ were seen. Formation of O^- was a common misconception, rather than recognising that two sodium atoms each lose one electron, and both electrons are gained by one oxygen atom to form an oxide ion (O^{2-}). A common error was for students to write oxygen ion instead of oxide ion.

03.3 Students found this question very challenging and instead of giving observations tried to explain what was happening in the reaction. Ver few students gave two observations for burning sodium in oxygen. A yellow flame was a common answer for those who gained one of the marks although 'flame' was insufficient. If students wrote 'smoke' they often did not state the colour and so did not achieve the mark. Many referred to the reaction of sodium with water so bubbles was a common incorrect response.

03.4 Again very few students gave two differences comparing burning potassium with sodium in oxygen. Most students did not know that potassium burns with a lilac flame. Students did not tend to write 'burns faster' for MP2 but they did achieve this mark by making a comparison of the two reactions, for example, by writing the reaction was more vigorous.

Question 4 (standard and standard/high demand)

04.1 Nearly half of the students correctly selected the order of discovery of the electron, proton and neutron. A third of students thought that the proton was discovered before the electron and chose the fourth option.

04.2 Just over a third of students calculated the number of times a proton is heavier than an electron. Most students were able to correctly round their answers to 3 significant figures although those who gained 1 mark invariably evaluated the ratio correctly but then incorrectly rounded the answer (1836.645076) usually by 'truncating' this to 1836. The most common error here was to invert the mathematical expression.

04.3 More than three-quarters of students deduced the number of neutrons in the bromine $^{81}_{35}$Br atom.

04.4 Only 20% of students deduced the number of electrons in the bromide $^{81}_{35}Br^-$ ion. The majority gain the number of electrons in a bromine atom.

04.5 This question was a good discriminator. Just under a third of students gained all 3 marks with a few students gaining 2 of the 3 marks for not giving their answer to 2 decimal places.

04.6 More than three-quarters of students correctly drew a dot and cross diagram for chlorine. When only one mark was gained this was usually for the two shared electrons in the overlap between the atoms. Some failed to show that there are six unshared electrons on each chlorine atom.

Question 5 (standard and high demand)

05.1 Just over 10% of students stated that solid sodium chloride does not conduct electricity because ions are not free to move. The majority of students answered by linking the conducting of electricity in the solid with no free delocalised electrons.

05.2 Just over half of students stated that sodium chloride solution also conducts electricity where liquid or molten. Many students did not read the question carefully enough or failed to understand that in solution was equivalent to dissolved and responded with either aqueous or in solution.

05.3 More than 40% of students named a correct element that could be used as the inert electrode with carbon or graphite being the most common response. Gold, silver and platinum were also creditworthy and were occasionally given by students.

05.4 Students found this question difficult. Students should be aware that halogens all exist as diatomic molecules and that a negative sign on an electron is necessary to balance the charges in the equation.

05.5 This question was very challenging but proved to be a good discriminator. The idea that water molecules break down to produce hydrogen and hydroxide ions was very rarely seen. MP2 was rarely awarded as students failed to provide all the necessary detail which included making reference to three terms: (hydrogen) ions, attracted and discharged/reduced. When one mark was gained it usually was for a reference to hydrogen being less reactive than sodium. MP4 was for explaining why the pH increased and when gained it was usually for stating that there was a decrease in number of the hydrogen ions; an increase in the relative number of hydroxide ions was a comparable answer for MP4 but was rarely seen.

Question 6 (standard/high and high demand)

06.1 Students found difficulty in describing how to obtain magnesium chloride from the reaction solution. Just over one third of students gained at least one mark. A number of students did not filter out the excess magnesium before crystallising the solution and many referred to magnesium displacing hydrogen.

06.2 A common response was that magnesium displaces the hydrogen without any explanation; many students did not appreciate that this is a redox reaction. Students should realise that metals always undergo oxidation which can be related to dot and cross diagrams in ionic bonding. In this question identifying what is oxidised (ie the metal) is easier than identifying what is reduced ie H+ ion (not hydrogen). Magnesium is oxidised during the reaction with hydrochloric acid as magnesium atoms lose two electrons. Students found it challenging to describe what happens to the magnesium atoms with only a quarter gaining more than one mark. Many students who stated that magnesium atoms were oxidised then went on to state it was because they gained oxygen. A common mistake was to say that atoms (not electrons) were lost.

06.3 Students found this calculation challenging but the question proved to be a good discriminator. A third of students gained at least one mark for initially calculating the number of moles of magnesium. About 20% went on to calculate the mass of magnesium chloride produced as 2.85 grams. Only a small percentage of students then went on to determine the concentration of the magnesium chloride solution produced; students struggled with the conversion of 100 cm^3 into dm^3 so a wide variety of answers were seen where a mass of 2.85 grams had been multiplied by ‘some factor of 10’.

Question 7 (standard/high and high demand)

07.1 60% of students identified that fullerenes and graphene both contain atoms in hexagonal rings. Diamond / graphite was the most common distractor selected.

07.2 In this question students were asked to explain why the structure of copper allows the conduction of thermal energy. Just under one half of students gained one mark for stating that delocalised electrons were responsible with approximately a quarter of these students then describing that these electrons move through the structure. The idea that these electrons transfer energy through the metal was infrequently recognised for the third marking point. Many answers confused the carrying of movement of electrical charge rather than thermal energy.

07.3 This question proved to be a good discriminator but students found the question difficult. Students were asked to explain why copper oxide has a high melting point. There was a lot of confusion over types of bonding and forces, with students often contradicting themselves during their response. The majority of those who gained 1 mark usually scored MP3 for stating that large amounts of energy is needed to break the strong forces.

07.4 Students had to describe why water has a low melting point. This question also proved to be a good discriminator. If a student refers to breaking the ‘forces’ or ‘bonds’ for then it must be clear they are referring to the intermolecular forces with no possible confusion that it is covalent bonds being broken. Students must explain that little energy is needed to break the bonds, less energy is insufficient. Nearly 40% of students gained at least 1 mark which was usually gained for stating that little energy is required to overcome the intermolecular forces. Few students described water as existing as small molecules which have weak intermolecular forces.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.