GCSE

CHEMISTRY

8462/1H: Paper 1 (Higher tier)
Report on the Examination

8462
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General comments

There were eight questions on this paper. Questions 1 and 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 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.

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 found this question challenging. It was expected that the lack of electrical conductivity and the low melting point would have suggested a non-metal and therefore section **D**. However, fewer than half of students gave this response, with distractors **A** and **C** both proving very attractive to students.

01.2 Nearly two thirds of students recognised element **R** as a transition metal and therefore in area **B**.

01.3 Fewer than 20% of students scored two marks, although more than half scored at least one mark. Students were asked to compare physical properties of Group 1 elements with transition elements. Many students gave chemical properties such as reactivity instead of physical properties. Others referred to atomic structure. Some students described a property of either a Group 1 element or a transition element without reference to the other.

01.4 Nearly all students could draw the electronic structure correctly.

01.5 The great majority of students referred to delocalised electrons in their answer. Many also referred to the electrons carrying charge. However, few articulated the idea that the electrons themselves move through the metal in a particular direction. Many implied that the movement was random by the use of words such as 'throughout' rather than 'through'. Some students incorrectly referred to electrons bumping into other atoms or electrons.

01.6 The great majority of students correctly identified the type of bonding.

01.7 The majority of students gave excellent descriptions of the transfer of two electrons from a magnesium atom to an oxygen atom to produce magnesium ions and oxide ions,with more than 80% scoring at least three marks. A few students showed a lack of understanding by subsequently referring to electrons being shared.

Question 2 (Standard demand)

02.1 Many excellent answers were seen, with a workable method laid out clearly in a logical order, and with added detail such as the use of a beaker to support a polystyrene cup, or using lagging to insulate a beaker. Answers often included a list of suitable apparatus for measurement of volume and mass, and details of important control variables such as the volume and concentration of acid.

Some students, however, tried to measure the loss in mass during the reaction, or even the volume of gas produced. A few compromised the experiment by heating the mixture with a Bunsen burner. Some students measured and varied the volume of sodium carbonate rather than the mass, despite being informed that the sodium carbonate was a powder and to investigate the change in mass.

Although most candidates referred to the measurement of temperature, the key step in the method that was most often missing was the instruction to measure the highest temperature reached by the mixture.

Repeating the experiment with a different mass of sodium carbonate was the most common method used but a method which involved adding successive masses of sodium carbonate to the same container could also gain full credit provided that the highest temperature reached was measured after each addition of sodium carbonate.

02.2 Most students determined the gradient correctly, with many using the coordinates of the points at the limits of the printed line. Some appeared to misread the scale on the *y*-axis, reading 28.6 as 28.3 and 22.2 as 22.1. Many did not annotate their graph; those who read their coordinates incorrectly made it very difficult for examiners to judge whether the *x*-coordinates corresponded to the given *y*-coordinates. Students should always show their working in full, including annotating the graph. Units were usually given correctly, but g/°C was often seen. C° is not a correct representation of degrees Celsius.

02.3 The vast majority of students extrapolated the line to the *y*-axis correctly and read off the value of initial temperature. A handful of candidates gave a value for the initial temperature without annotating the graph so were not awarded any marks.

02.4 Nearly all students correctly identified **C** as the correct graph.

02.5 Fewer than half of students scored both marks, although nearly 80% scored at least one mark. Activation energy was a common incorrect response for either **X** or **Y**. Other incorrect answers included time for **Y** and temperature for **X**.

02.6 Most students referred correctly to the relative energies of the reactants and products, or to the loss of energy shown by those energies. A few students referred to temperature or heat rather than energy and were not given any credit.

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

03.1 This was generally well answered. Some students omitted to mention that diamond is a giant structure, and a few stated that each atom is bonded to three others instead of four, despite the diagram provided. Although the majority of students mentioned covalent bonding, many contradicted themselves by referring to intermolecular forces; these are not present in diamond and negated the mark for covalent bonding.

03.2 There were many excellent answers. However, a large number of students contradicted themselves by referring to ‘strong intermolecular forces’ as well as strong bonds. There are no intermolecular forces in diamond, let alone strong ones. Students sometimes referred to ‘more energy’ required to break the bonds. This did not gain credit as there was no idea of what the energy was being compared with.

03.3 Most students correctly identified the molecule as a fullerene.

03.4 Many students answered correctly in terms of the hollow shape of the molecule. Only a few referred to its non-toxic or unreactive nature. Some students concentrated on the ease of movement of the molecule around the body. This did not gain credit, as this does not explain why the molecule is useful for drug delivery.

03.5 More than a third of students scored all three marks. Partial credit could be obtained by those who attempted to calculate the number of moles of molecules made by 1 mole of carbon atoms, and then multiplying their answer by the Avogadro constant. There were many attempts to calculate various masses or relative molecular masses which were not relevant to the question set.

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

04.1 Only about 40% of students scored this mark. A visible observation was required, such as solid remaining at the bottom of the beaker, or solid no longer disappearing. Merely rewording the idea that zinc oxide is in excess did not gain credit. Many students referred incorrectly to zinc rather than zinc oxide. The idea of a solid appearing was not given credit, as the solid was added in the first place.

04.2 Few students gained this mark. Many students said the reason was to use up all the acid, without considering why that was necessary - answers in terms of ease of removal of the excess reactant were required. Whilst students seem very familiar with the method for making a salt, they appear to be less familiar with the reasons for each step.

04.3 This was answered correctly by just over half of students. Some suggested zinc or chlorine; whilst zinc would work, it is not a compound. Others suggested using salts such as zinc sulfate.

04.4 Many students correctly described the two-step process of heating to crystallisation point, followed by leaving the solution to cool and crystallise. A few students referred to evaporating the zinc chloride, rather than the water, from the solution. Many students restricted themselves to one mark; either they did not heat the solution, they did not give a reason for heating, or they heated to dryness.

04.5 Fewer than a quarter of students answered correctly. Many students tried to incorporate chloride into their equation. Equations were often not balanced in terms of charge.

04.6 This was well answered, with most students referring specifically to zinc in this reaction rather than to oxidation in general.

04.7 This question was well answered. However, some students drew an electrolytic cell rather than a simple chemical cell, with an electrolyte in a beaker and copper and zinc electrodes dipping into it.

Question 5 (Standard, standard/high and high demand)

05.1 Nearly half of students described how a specific observation would differ. Vague comments about a more violent reaction, with no specific visual observation, did not gain credit.

05.2 Most students scored at least two marks. They knew that rubidium would lose an electron more easily, and that it was the larger size of the atom that was responsible (often expressed as the rubidium atom having more shells). The description of the weaker attraction of the rubidium nucleus for the outer electron was less well expressed; some students omitted to say that the attraction was for the outer electron or that the attraction was between the outer electron and the nucleus. Some gave an inappropriate description of the attraction, such as intermolecular or magnetic. Some contradicted their attraction argument by saying that the outer electron in rubidium is less shielded from the nucleus, rather than more shielded.

05.3 Only about a sixth of students scored full marks. Many knew that one of the products was hydrogen, and could write its formula correctly. However, far fewer knew that RbOH was the other product. Of those who did, most managed to balance the equation correctly.

05.4 Fewer than half of students gave the correct answer. Nearly as many, though, stated that the noble gases all have eight outer shell electrons, appearing to forget about helium.

05.5 More than half of students completed the calculation successfully and rounded to the appropriate 3 significant figures. Common errors were to divide by 63 (sum of the mass numbers) or 3 (number of isotopes) rather than by 100.

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

06.1 Two thirds of students selected the correct half equation. A significant number chose a distractor in which Na was present at the start rather than formed in the reaction.

06.2 Most students realised the need to prevent the products from reacting together and reforming sodium chloride. However, a significant minority failed to appreciate that the reverse reaction would occur and instead focused on preventing the products from mixing or ensuring product purity.

06.3 Only 60% of students recognised that ions must pass through the mesh. Nearly all other responses were ‘electrons’. Many students seem to think that an electric current can only be conducted by electrons moving, even through a solution in which there are no free electrons.

06.4 Most students recognised that hydrogen ions would be present in aqueous sodium chloride. However, only just over a half of students also recognised that hydroxide ions were present. Some stated that the fourth ion would be oxygen, showing a lack of understanding of the ionisation of water.

06.5 A majority of students recognised that the alkaline solution must be sodium hydroxide solution.

06.6 This was a high demand question which students found very challenging. The most common mark scored was for the sodium ions and hydroxide ions remaining in solution after the electrode processes. However, many students did not refer to ions. Others thought that hydroxide ions or sodium ions would be made, rather than being in the solution throughout the process. Whilst students often correctly stated the product at each electrode, few described the actual processes occurring at the electrodes as required by the question. Some otherwise creditworthy responses were let down by referring to chlorine ions instead of chloride ions, or by confusing the polarities of anode and cathode, or by confusing oxidation and reduction.

Question 7 (Standard, standard/high and high demand)

07.1 This was well answered, with more than half of students scoring both marks. There was, however, some ambiguous use of the word ‘it’ such as ‘it shows that it is below carbon because it displaces it’. If it was not clear what ‘it’ referred to, credit was not given.

07.2 Only 10% of students were awarded both marks, although nearly 60% scored at least one mark. Many students realised that aluminium is extracted by electrolysis, although some stated that aluminium would be extracted by the use of a more reactive metal. Although many mentioned the high energy cost of electrolysis, few compared electrolysis to the lower energy cost of heating coal to obtain carbon. Other students did state that extracting aluminium requires more energy than forming carbon, but did not explain why.

07.3 Many students realised that the products both being solids would make their physical separation difficult. Some appeared to misunderstandd what ‘separate’ means, and described the difficulty of decomposing magnesium oxide; this did not gain credit. Another common incorrect approach was to say that magnesium is high in the reactivity series. Whilst true, this was not relevant to the question set.

07.4 Those students who adopted a systematic approach, either using moles or reacting masses by proportion, had little difficulty in scoring most or all of the marks. In a multi-step calculation it is essential that each step is shown in the working so that marks for working can be awarded. The most common error was to use 48, instead of 24, for the M_r of Mg, giving an answer that was twice the correct value. Nearly all students carried out the unit conversion correctly. Some students calculated the correct final answer (960 g) but used an incorrect method. Such responses did not score full marks.

07.5 This was well answered. However, there were many blank responses.

07.6 This was a high demand calculation, and students found it difficult to analyse the correct approach to take. The gas molar volume was not provided, because it was not needed. Indeed, with the water being formed as a gas, a value of 24 dm^3/mol was not correct. Even so, those students who adopted the approach of converting gas volumes to moles were given full credit if they succeeded. Few did, as a four-step calculation with simple numbers was turned into a seven-step calculation with a unit conversion by electing to follow this approach.

Students needed to use the equation to realise that the SiO_2 formed is a solid, not a gas. They were also told that the oxygen is in excess; that means that the Si_2H_6 is the limiting reactant, and that the gases after reaction would therefore be the water vapour and the remaining oxygen. All that was therefore necessary was to multiply the volume of Si_2H_6 by 3 to find the volume of water vapour formed, and by 7/2 to find the volume of oxygen used. Subtracting that volume from 150 cm^3 would then give the volume of excess oxygen, and adding the volumes of the two appropriate gases together gave the final answer. Only one sixth of students scored at least one mark, which was usually for calculating the volume of water vapour produced.

Question 8 (Standard, standard/high and high demand)

08.1 While over a half of students scored one mark on this question, very few scored all four. Many referred to a pH being more or less acidic, without referring to higher or lower pH values. Few students mentioned hydrogen ions, so limited themselves to Level 2. The strength of an acid was explained better than the concentration; very few students could state that the more concentrated the acid, the more of it there is per unit volume. Even those who did know the definition often stated that the concentration of the acid was the number of hydrogen ions per unit volume, rather than the acid molecules. There were vague statements such as the strength of an acid depends on the extent of ionisation, without giving the direction of that dependency. Some otherwise good answers were compromised by incorrect links to pH, such as ‘the stronger the acid the higher the pH’. Many students made incorrect statements trying to link strength to concentration, not recognising that they are entirely separate.

08.2 Most students were able to explain that the first titration is anomalous and the mean of the other four titrations is used. Some correctly described this as taking the mean of the concordant results, or the mean of the results within 0.10 cm^3. Incorrect answers included that the value used was the mean of all five results, or that it was the mode or median of the results.

08.3 There were many fully correct answers. Some students use a table approach without showing their working for each entry in the table, so that if an intermediate step is incorrect it is difficult to see what the student has done in subsequent steps. Some students calculated their number of moles incorrectly due to not converting their volume from cm^3 to dm^3; in this case they often repeated the error, obtaining what looked like a correct answer. In a multi-step calculation working must be shown.

08.4 Although many students scored one mark, very few scored all three. There was a lot of confusion evident over the mechanism of conductivity in a solution. Many students stated that ions allow delocalised electrons to be passed from one to another, rather than the flow of ions themselves constituting the electric current. Many of those students who did understand the mechanism only considered the removal of one pair of ions (usually the barium and sulfate ions, but sometimes the hydrogen and hydroxide ions), and few said categorically that there were no longer **any** ions which were mobile in the solution.

08.5 Few students recognized that the excess barium hydroxide provided ions that were free to move in solution. There was confusion evident between neutralised in the context of positive and negative charges, and neutralised in the context of pH. Some stated that OH^- ions contain a delocalised electron.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account of 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.