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General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit Chemistry 2

Report on the Examination

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Additional Science / Chemistry
Higher Tier CHY2H

General

The majority of students were able to attempt almost all question parts, with the most able demonstrating an excellent understanding of concepts. Increasing numbers of students struggle to communicate their ideas effectively due to the imprecise use of terminology, and poor grammar.

Question 1 *(Standard Demand)*

(a) Most correct responses focussed on the lack of knowledge, technology or equipment at that time, with a number of other responses also gaining credit relating to scientists not being able to obtain the high temperatures needed for the reaction. The few incorrect answers were varied, but a number stated "because it's a white solid". A surprising number of candidates thought "alumina" itself was a type of metal.

(b) There were many correct responses for this question. The most common incorrect response suggested that Oersted's experiment was not thought to be reliable as only tiny pieces of aluminium were obtained. Other non-creditworthy answers stated that he (Oersted) did not repeat the experiment, or left the examiner to decide who had tried to repeat the experiment by stating that "it could not be repeated". "Not enough evidence" was insufficient for credit. There were a lot of examples of poor syntax, so that it was, sometimes, difficult to tell whether the candidate was referring to Oersted or 'other scientists'.

(c) Most students recognised the reaction in step 1 to be endothermic, and therefore requiring heat to make it work. Of those answers not gaining credit, the most common ones focussed on heat increasing the reaction rate or the number of collisions taking place.

(d) The correct word equation was given by a large majority of students. Those who failed to gain credit gave incorrect formulae or very rarely, a compound of aluminium, eg aluminium hydroxide, water or hydrogen.

(e) Few students gained 2 marks, but those who did gave excellent responses. Most answers gaining credit were awarded one mark for recognising that the properties of the new metal were different from or were compared with those of other known metals or elements. The most common reason for students not to gain credit was because they just repeated the final sentence of the information in the box, "He tested the aluminium and recorded its properties". To gain credit students were expected to explain how the results of the tests would show that a metal had been produced, and that the metal was different from other known metals. A surprising number of students expected Wohler to be able to examine the nuclear structure.

Question 2 (Standard Demand)

(a) **(i)** The vast majority of students gained full credit. Of the few who didn't add the A_r values, some multiplied or divided them, and others made little attempt at the question. A few students gained 1 mark by realising that they should add 16 + 24, but giving the answer as 30.

(a) (ii) Again a very high proportion of students gained both marks. Very occasionally 1 mark was awarded for 24/40 followed by incorrect arithmetic. The most common answer gaining 0 marks was to confuse the A_r of magnesium with that of sodium and divide 16/40, giving 40%. Sometimes 16/24 = 66.67% was seen.

(a) (iii) While the majority of students gained the mark, those who did not often showed a lack of understanding of how to use their correctly calculated answers to (a)(i) or (a)(ii) for this calculation, so error carried forward (ecf) was rarely awarded. The main ecf was 16/40 x 100 = 40% for (ii), then 40% of 25g is 10g. A number of wrong answers gave masses of magnesium which were significantly larger than the 25g of magnesium oxide to be made. Students should be encouraged to consider whether the answer they reach is reasonable when doing calculations.

(b) (i) There were any correct answers, spread over all 3 marking points, and clearly expressed. The majority of students could identify at least one experimental error, with the loss of magnesium oxide, or its equivalent, being the most popular response. It is encouraging that students appear to have had experience of this reaction. Answers which did not gain credit often gave insufficient detail, for example weighing error, apparatus error or human error. It was disappointing that a proportion of responses were poorly expressed, so the student's intended meaning was difficult to discern.

(b) (ii) Many students gained marks from their understanding that repeating the experiment would improve the reliability, enable the student to identify anomalous results or calculate a mean. More able students gave all of these points. A number of students suggested that repeating would enable the student to compare their results, but this needed further explanation eg to identify anomalies to gain credit. A mention of fair testing was not considered enough on its own for credit, nor was just checking for results. A small minority of weaker responses confused precision, accuracy and reliability.

Question 3 *(Standard / High Demand)*

(a) A high proportion of students completed the electronic structures correctly. Some attempted to amend the charge on the chloride ion, but this did not affect the marks gained. The electronic structure of the chloride ion proved slightly harder than that of the magnesium atom, with some students giving a 2, 8, 6 structure. 2, 8, 1 was the most common error for Mg. 2, 6 for Mg (gaining 2 e^-), or 2, 7 (gaining 1e^-), or 2, 8, 1 (losing 1e^-). A minority of students did not attempt the question or had clearly not understood the concept of electronic structure.

(b) (i) A minority of students gained credit. Electrolysis remains a common error in answers to questions of this nature. Evaporation was also a frequent error, and is not applicable here as the other product in this reaction is aqueous calcium chloride, which would remain along with the magnesium hydroxide after evaporation.

(b) (ii) This question was well answered. The most common error was chlorine. Chloric acid and to a lesser extent, sodium chloride were also common errors.

(c) (i) A majority of students identified ions as the particles which must be be mobile to carry the charge through the electrolyte. An unqualified reference to the movement of electrons gained no credit, and a substantial proportion of incorrect responses referred to the movement of electrons, or less frequently atoms, in the magnesium chloride.

(c) (ii) Oxidation as loss of electrons is well known. The most common errors were confusing oxidation with reduction (ie electrons are gained), or describing oxidation as a reaction involving oxygen.

(c) (iii) More able candidates gained credit. Common errors included adding $2e^{+}$ on the left hand side. Some candidates failed to complete the equation as they omitted the + before their correctly placed e^{2-}, others gave $+e^{2-}$.

Question 4 ***(Standard / High Demand)***

(a) (i) Although a small minority of students described the diagram in the stem of the question rather than the structure of a metal, the majority of students demonstrated a sound understanding of metallic structure with correct use of terminology. However, some candidates who were clearly familiar with the structure of a metal failed to state the type of particles in the lattice (atoms/positive ions). A few students referred to ionic bonding or intermolecular forces, limiting their marks to a maximum of 2 of the available 3. A number of candidates unnecessarily linked structural points to properties, eg heat transfer, or mentioned that the layers can slide.

(a) (ii) The minority of students who failed to gain credit many based their answer on the idea that the close packed structure enabled vibrating particles to transfer heat energy.

(b) (i) A substantial majority of students gave smaller or very small as their response. Some referred to the larger surface area of nanoparticles compared to normal sized particles. There were very few incorrect responses.

(b) (ii) A high proportion of students correctly identified the larger surface area of nanoparticles as aiding heat transfer.

Question 5 ***(High Demand)***

A reasonable proportion of students gave completely correct calculations. A substantial number of students were able to complete the first 2 steps of the calculation successfully, but were unable to produce a ratio from their answers. Common errors included dividing A_r by % and incorrect rounding to produce the ratio. Weaker students made attempts at adding 16 and 56 and dividing by 72.

Question 6 ***(Standard / High Demand)***

(a) A very high proportion of students gained the mark. The most common error was ionic bonding.

(b) (i) The majority of incorrect responses focussed on an explanation of how increased pressure would affect the rate of the reaction, or that the reaction is exothermic. Other students not gaining credit gave some detailed, but confused applications of Le Chatelier's principle to the question. However, the minority of students gaining credit gave a clearly explained response.

(b) (ii) A small majority of students gained credit. A number of incorrect responses suggested that the ethanol would evaporate at higher temperatures. Some incorrect responses focussed on the rate of the reaction and number of collisions, or stated that a higher temperature favours the reverse reaction.

(c) In responses to high demand questions students are expected to use correct terminology, so referring to atoms was inappropriate in this context. The most able students gave clear explanations. Some students who gained the first marking point went on to just state that the particles collide more (ignoring the time aspect), so did not get the second mark. Students who gained no credit often pursued an explanation based on particles gaining energy as pressure is increased.

(d) Although "weak intermolecular forces" is a well-known phrase, a substantial number of students demonstrated their lack of understanding of its meaning by discussing "weak intermolecular forces between <u>atoms</u>", or "weak intermolecular bonds that are covalent". Some students who failed to gain credit wrote about "weak bonds" without specifying which bonds; others referred to weak covalent bonds.

Question 7 ***(High Demand)***

(a) (i) This proved to be a very discriminating question. Of the students who gained less than three marks, many mentioned other types of bonding, including ionic bonding and intermolecular forces. Some students even included all 3 types of bonding for good measure – no doubt hoping that one would be right and pick up some marks! In this and 4ai, some students wrote about <u>bonds</u> being joined together strongly – muddling bonds with particles being bonded together, eg "bonds are held together by strong forces of attraction." Many students gained credit for "giant covalent structure", but then went on to mention intermolecular forces.

(a) (ii) The majority of students recognised that the presence of delocalised or free electrons enables graphene to conduct electricity. However, only the most complete responses (a minority) clearly explained that each atom provided one delocalised electron. As in 7(a)(i), examiners had difficulty interpreting some students' answers due to imprecise language eg rather than each atom having one electron not used in bonding, some students wrote that each molecule has one spare atom, "only 3 bonds are connected, so one bond is free to move around", free atoms. Some students only scoring one mark said that there was one free electron, but omitted to say <u>per atom.</u> In high demand questions, students are expected to be able to express their understanding of chemical concepts clearly, and in such a way that examiners can readily interpret their answers, even on quite complex topics such as why graphene is strong or conducts electricity. Where answers are difficult to interpret, or are ambiguous due to imprecise use of language, credit cannot be awarded.

(b) A majority of students realised that a screen with a large number of carbon layers would not be transparent. A significant number of students also gained credit for recognising that with multiple layers, the layers could slide. However of those who gained no credit, many stated that the screen would be too thick, without specifying a problem which would arise from this. Others felt that the multiple layered screen would not be strong enough, or be too thick and rigid to respond to touch.

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