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General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit Chemistry 2

Report on the Examination

2011 examination – June series

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Additional Science / Chemistry
Higher Tier CHY2H

General

The paper proved to be very discriminating across the range of grades from A* to D. There were a number of candidates who would have had a better opportunity to demonstrate their ability if entered for the Foundation Tier, but there were also a number of candidates who gained full marks, and many excellent scripts were seen.
Candidates appeared to have time to complete the paper, and almost all candidates attempted virtually of all the questions.
Candidates are reminded to write with black ink.

Question 1 *(Standard Demand)*

(a) Most candidates gained this mark, recognising that the smell is caused by bacteria, which are killed by the silver nanoparticles. Some candidates failed to gain credit because they thought that the silver nanoparticles trapped, absorbed or neutralised the smell.

(b) The vast majority of candidates indicated in some way that nanoparticles are much smaller. Some gave the definition from the specification. The few incorrect answers often referred to surface area or nano-sized without offering further explanation.

(c) This question was found to be more challenging, though a majority of candidates gained the mark. A number of candidates answered this with the idea of more particles being used or the idea of the smaller particles getting between the fibres of socks, or into pores of skin to kill bacteria. Credit was awarded for a correct reference to a larger surface area or a faster reaction with nanoparticles.

(d) This question was well answered. The few answers which did not earn credit lacked detail in one or both marking points, eg failing to suggest when the silver particles could be released (during washing), or where they might go (into rivers) for the first marking point. Similarly for the second marking point, some candidates did not specify the damage which could arise. A very small minority appeared not to be referring to the article at all when answering the question, despite the clear wording of the question to use the information in the article.

Question 2 *(Standard Demand)*

(a) The majority of candidates gave the correct response. Many of the candidates who did not gain credit did not use the information from the equation as instructed in the question. Many referred to the water and carbon dioxide as waste or by-products without suggesting why they would escape from the tube. A substantial number of incorrect responses referred to carbon dioxide evaporating, or either/both water or carbon dioxide escaping in the flame or being burnt off. A small number of candidates described the equation in words without addressing the question, which required interpretation of the symbols rather than a verbal retelling of the equation. Careful reading of the question was essential.

(b) (i) In this calculation both marks could be gained for a correct answer without working, but candidates should always be encouraged to show their working. The overwhelming majority were able to calculate the M_r of copper oxide. The most commonly seen error was 320, obtained from multiplying 80 by 4 or 16 × 4 + 64 × 4. These candidates hadn't understood the meaning of M_r. Some candidates recognised the need to add 16 and 64 so gained 1 mark.

(b) (ii) As with part (b)(i), this question was correctly answered by the overwhelming majority of candidates. Commonly seen errors included calculating 16/64 × 100%. Some candidates chose oxygen rather than copper as given in the question, so calculated 16/80 × 100%.

(b) (iii) The majority of candidates gave the correct response. Candidates should be encouraged to consider whether their answer is realistic, and if not, to check it. A lot of answers were greater than 4 g and therefore unrealistic. This proved the most challenging of this sequence of calculations, even for candidates who had successfully calculated the percentage of copper in part 2(b)(ii). (4/80) × 100 = 5 g was common error, as was 4 × 64 = 256 g.

(c) (i) The responses to this question were creditworthy for the vast majority of candidates. Some made arithmetic errors leading to impossible answers, often greater than 3.5. As with the previous question, candidates should be encouraged to consider whether their answer is realistic. A very small minority didn't know how to calculate a mean. A small minority also made rounding errors.

(c) (ii) Although there was a high proportion of correct responses, mostly either measuring to more decimal places or using a smaller scale (division), some candidates were unable to differentiate between accuracy and precision. There was also some confusion with reliability. Errors included suggestions to repeat the experiment, or explaining precision using the word "accuracy".

(c) (iii) This question led to a wide variety of possible correct answers. Most of the marking points on the mark scheme were well represented. It was answered well by the minority of candidates who were specific in their answers and who related the error they suggested clearly to the experiment described. Many candidates appreciated the possible impurity of the copper oxide, the idea that the reaction may be incomplete, that insufficient methane may have been used, or that there may have been various problems with weighing the copper or copper oxide. One of the most common errors, where the candidates did not achieve the marks in this question, was simply to name 'human error', 'weighing error' or 'zero error' without qualifying this in terms of this experiment or without explaining the error further so its meaning was clear. The other common errors seen were answers which were too imprecise such as describing measurements rather than mass or weighing, and referring to measuring devices or measuring tools rather than naming the balance. Some candidates did not specify what was being weighed. It appeared that a number of candidates were not very familiar with this experiment or even with basic apparatus such as balances.

Question 3 *(Standard Demand)*

(a) This question discriminated well. The majority of candidates gained credit for both available marking points, but imprecise language made it difficult at times for examiners to award marks. The phrases 'particles move more' or 'particles collide more' did not gain credit. Misconceptions included the idea that particle collisions produce energy. Most candidates gained the first marking point. Many of the candidates who did not gain the second mark only wrote that there would be more collisions. They did not convey the idea of frequency – ie particles collide more often, or the higher energy level of collisions. A small minority referred to heat as a catalyst.

(b) A large majority of candidates gave correct responses. Common errors seen included suggestions to add more acid or rock, and to increase the pressure. Thoughtful reading of the question should have informed candidates that there were no gaseous reactants.

Question 4 *(High Demand)*

(a) The vast majority of candidates gained credit in this question. Very few candidates confused exothermic and endothermic. Some candidates attempted to answer in terms of the relative amounts of energy taken in and released on the breaking and formation of bonds. Although a number of these responses were successful, there was also some evidence of confusion, and these candidates could have been more successful if they had simply referred to exothermic reactions giving out energy.

(b) Approximately half of the candidates gained this mark, with thermal being a commonly given incorrect response.

(c) (i) Again approximately half of all the candidates gained this mark. The most common error was to give just six electrons on the outer shell, the electronic structure for an oxygen atom rather than an oxide ion. It was pleasing to see that the clarity of most of the responses enabled examiners to award credit where it was due, although when sometimes candidates crossed out their crosses or obliterated them with a large blob/dot examiners had difficulty distinguishing crossings out from electrons.

(c) (ii) This question proved to be slightly more challenging than the previous question. Many misconceptions were evident, such as ‘positive and negative electrons’, ‘strong intermolecular forces between ions’, or ‘oppositely charged atoms’. A significant minority of candidates thought the compound to be covalently bonded. Some simply gave ‘ionic bonds’ or suggested shared electrons. Many answers which didn’t gain credit referred to ‘strong bonds’ without explaining what caused the attraction. A number of candidates described the transfer of electrons, without going on to say how this gives rise to the attraction.

Question 5 *(High Demand)*

Electrolysis is often a challenging topic, and this question was no exception. It was, however, very discriminating, enabling stronger candidates to demonstrate their understanding of this important area of chemistry. In question 5(a)(i) and 5(a)(ii) the majority of candidates were able to name electrons as the current carriers in the metal wires, but only a minority could identify ions as the current carriers in the solution.

(a) (i) the most common error was giving the name of the metal – ie copper, rather than the name of the particle. A number of candidates gave more than one type of particle, eg ‘electrons and protons’. This was treated as a list by examiners, so the incorrect inclusion of protons meant that no credit could be given for electrons.

(a) (ii) Common errors included electrons, protons, neutrons, water. The wide variety of incorrect particles given suggested that only the more able had an awareness of the charge carriers in solution.

(b) (i) This question, along with the accompanying explanation in part (a)(ii), was challenging even for A* candidates, as it required the ability to understand and apply the concept of reactivity to electrolysis. The most common incorrect element given was zinc, but a significant minority of candidates gave Cu^{2+} or copper(II) ion, rather than the symbol or name of the element. The question asked for the element formed, so copying copper(II) ions from the table gained no credit. Although metals were most often given, non-metals also appeared frequently.

(b) (ii) This question elicited some accurate and well expressed responses. It was marked independently of part (b)(i). Most candidates gained one mark for indicating that the element should form positively charged ions, thereby showing a clear understanding of the concept of opposite charges attracting. However, only the most able candidates gained credit for realising that the least reactive element was discharged. Most incorrect answers related to zinc, stating it was discharged because it was the most reactive. Others suggested that iron(III) was discharged as it has the highest positive charge, so was most strongly attracted. The most common response was ‘zinc is the most reactive positive ion’, gaining one mark. A lot of confusion in terminology was apparent, for example the use of ions for electrons, atoms for ions, ion for electrode and vice versa. Examiners read about positive electrons and answers referring to the highest charged ion or the most reactive element as the ‘strongest’ ion or element. Some candidates felt that high reactivity caused greatest attraction to the cathode.

(c) (i) While electron loss is widely known as oxidation, many candidates were unable to state in this context which particle was lost with atoms, ions and protons being suggested. Many of the incorrect answers stated that oxidation was the gain of electrons. Others expanded OIL (as in RIG), but failed to apply the learning aid to the equation given in the question. Some answers focussed on the loss or gain of oxygen rather than electrons. Others focussed on the change in the charge on the ions.

(c) (ii) Although only a minority of candidates gained credit there were some valiant attempts at this question. Some candidates introduced other elements, eg Na or Cu, or turned the final H_2 into H_2O. Many others gave e^+, or subtracted electrons on the left hand side of the equation. A number of candidates didn’t recognise this as a half equation, so didn’t include any electrons, for example simply adding H^+ or H^- on the left hand side. Many candidates managed nearly correct answers, for example with just a sign or charge wrong. This suggests that candidates may have tried to learn the half equations without understanding them.

Question 6 *(High Demand)*

(a) Empirical formulae calculations can be very challenging, but it was pleasing to see that a majority of candidates gained 2 or more marks, and most were able to make a realistic start to the calculation. Having successfully started the calculation by dividing the mass by the A_r for each element, a significant number of candidates found obtaining a whole number ratio challenging, and so rounded the ratio of 1:1.3 to give 1:1, and hence PbO as the formula, gaining credit for the correct working, though not for the incorrect answer. Even lower scoring candidates were aware that division was needed to start the calculation, but some were unsure about what to divide. Other common errors included Pb_4O_3 (obtained by confusing and swapping the elements part way through the calculation, or by dividing the A_r by the mass for each element), and Pb_3O_2 (obtained by dividing 0.64/32 for oxygen). It was pleasing to see that many answers were clearly written with logically presented working, enabling examiners to award the credit due. A small minority of candidates continue to give a jumble of numbers, or no working at all. If no correct working was given or discernable, then 2 marks were awarded if a correct answer is given. Correct working had to be shown to access the remaining marks.

(b) (i) The majority of candidates gained credit in this question. The most common errors included putting more electrons in the outer shell of sulfur than 2 lone pairs, adding an extra electron to the hydrogen shell, or giving only 2 lone electrons on the sulfur shell. A minority of candidates put 3 bonding electrons in the overlap between the hydrogen and sulfur shells. As with 4(c)(i) , if crossings out are necessary, candidates should be encouraged to make the diagram clear.

(b) (ii) This question revealed a number of misconceptions, and discriminated well. Candidates showed some confusion between covalent bonds and intermolecular forces, with many stating that covalent bonds are weak. There were some excellent responses, but others showed that candidates had learnt the phrase 'weak intermolecular forces', while the rest of their answer revealed that they did not understand it, for example stating that covalent bonds have weak intermolecular forces. Examiners found occasional references to ionic bonds or delocalised electrons. There were many references to unspecified weak bonds.

(b) (iii) The majority of candidates gained this mark with 2 often seen as an incorrect response.

Question 7 *(High Demand)*

(a) (i) The majority of candidates gained at least 1 mark. Some candidates gave the names of specific elements or ions, or of compounds not containing the desired element. Rock or soil were commonly given errors. Those who gave the name of another element didn't understand the nature of an element, for example some candidates thought that oxygen would contain hydrogen. Some candidates reversed the two answers, or gave the same answer for both.

(a) (ii) This question discriminated well, with the highest scoring candidates giving full but succinct explanations. Many candidates remembered that 450 °C is a compromise temperature, but had difficulty explaining why. Few candidates were able to explain that it is the exothermic nature of the forward reaction which causes a high temperature to give a low yield. Some candidates who had not understood the nature of equilibrium referred to the compromise as being between rate and cost (high temp gives good rate but expensive). Of those candidates who gained 1 mark, it was usually gained for a statement that a lower temperature would cause the rate of the reaction to be slow. Only the most able candidates were able to fully explain the links between temperature, rate and yield and apply their understanding to this reaction. A small number of candidates referred to the reaction 'burning up' if the temperature was too high, to enzymes/molecules denaturing, atoms destroyed at a high temp, to 450 °C being the boiling point of hydrogen and nitrogen or to energy being wasted if higher temps were used. Some candidates simply stated that the process 'will not work' at certain temperatures.

(a) (iii) The majority of candidates named the acid correctly. Common errors included nitrate, sulfuric, nitrogen and hydrochloric acids.

(b) Only a minority of candidates realised that the main reason for the advantage of the Haber process over mines is that it too could produce fertiliser, and of those a disappointing number went on to give creditworthy reasons for the Haber process being better. Many candidates suggested that the Haber process is cheaper, easier, faster or more efficient than mining without giving any qualification, so were unable to gain credit. Some candidates thought that the mine produced ammonia.

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

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