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General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Report on the Examination

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Chemistry
Higher Tier CHY3H

General

This report should be read in conjunction with the published Mark Scheme. Although most questions were answered reasonably well, the following questions proved particularly difficult for nearly two third of students: Question 3(b) – the production of scale from hydrogen carbonate solution; Question 5(c)(i) – calculation of a mean while taking into account an anomaly that has not had attention drawn to it; Question 5(c)(ii) – an extended and unstructured titration calculation.

Other questions that were poorly answered by at least half of the students were: Question 1(c) – many students effectively repeated the information in the question without adding anything; Question 4(a)(i) – providing a reason based on chemical properties; Question 5(a)(ii) – confusing of the Arrhenius and Brønsted-Lowry theories of acids. Many of the questions that were less well answered tended to be those that involved calculation and those that required explanation or use of specific scientific terms. Students do need to read questions carefully to ensure that they are answering as required.

The vast majority of scripts were concise and legible. Some students still persist in using blue ink instead of black and this can cause legibility problems when scanned. Few students had major difficulty with the paper as a whole. These weaker students perhaps would have been better suited to the Foundation Tier Paper (CHY3F), or later entry for the examination in May once they had been better prepared and gained in maturity.
Questions 1 and 2 were standard demand questions and were common with Questions 5 and 6 on the Chemistry Foundation Tier Paper (CHY3F).

Question 1 *(Standard Demand)*

(a) (i) Most of the students were able to correctly identify the activation energy.

(a) (ii) A vast majority of the students were able to recognise that the negative enthalpy change B on the diagram indicated that the reaction was exothermic.

(b) (i) Most students made a suggestion worthy of credit. A common error was to confuse the crucible and the beaker, for example by suggesting that the crucible should be insulated. As the crucible was clearly labelled in the diagram, this suggests that many students did not look at it. Also common were the suggestion that the beaker should be placed on or moved closer to the crucible and the suggestion that the beaker be replaced with a polystyrene cup.

(b) (ii) Most of students were able to undertake both parts of the calculation correctly.

(b) (iii) The majority of students scored one mark. Most failed to obtain two marks because they effectively gave the same answer twice, such as two measurement errors. Others were too vague, for instance mentioning only ‘measurement error’ without relating this to the experiment with an indication of what might have been measured incorrectly. A sizeable proportion ignored the direction in the question to identify reasons other than energy loss to the surroundings, giving answers that would have been relevant to question 1(b)(i) but which were not allowed here. Also popular were answers pertaining to faulty equipment and answers addressing precision or reliability rather than accuracy, such as repetition of the experiment.

(c) About half of the students gained the mark, with a wide variety of reasons given. Many students were not awarded a mark because they effectively repeated the information in the question: food labels provide information about the energy released by the food 'so that we know how much energy is released by the food'.

Question 2 ***(Standard Demand)***

(a) (i) Just under half of students were awarded both marks; of those who were awarded only one it was almost always for the identification of carbon dioxide. The commonest error was to suggest that the test showed the presence of carbon ions, or sometimes carbon and oxygen ions. A few students misunderstood the question, giving answers such as 'produced' and 'some' respectively for the missing words.

(a) (ii) The majority of students were awarded both marks; of those who were awarded only one it was usually for the identification of litmus. A common error was to write 'ammonium' or 'ammonium hydroxide' instead of ammonia. Again, a few students misunderstood the question in a similar way to 2(a)(i).

(b) (i) Most students gave the correct answer that the solution was blue, but many recalled the test for copper ions and stated incorrectly that a blue precipitate was formed. This was allowed if they identified sodium hydroxide as the agent required for the test; unfortunately, many did not. Students also lost marks by answering imprecisely, for example by stating that 'copper turns water blue'; by missing out the word 'ions' they produced an incorrect statement. A few students wrote about alkaline solutions, perhaps confusing the blue coloration with that of litmus or universal indicator in alkaline solution.

(b) (ii) Many students achieved both marks. It was generally well known that the precipitate was white, but many students were confused as to the reagent needed for the test, sodium hydroxide and silver nitrate being the most common incorrect suggestions.

Question 3 ***(Standard / High Demand)***

(a) (i) The great majority of students produced a satisfactory curve. Those not awarded a mark generally lost it through having double lines. A few did not include the point on the y axis.

(a) (ii) The great majority of students were able to read the value correctly from their graph. There were two common errors. One was missing a decimal place, writing 0.75 instead of 0.075; the second was to read the large scale divisions correctly but then to subdivide wrongly, reading a small square as 0.01 rather than 0.05 to give responses such as 0.055 instead of 0.075.

(a) (iii) The majority of students achieved both marks. Most who did not gained one mark for correctly reading at least one of the points from the graph; incorrect values of 0.154 and 0.052 were most common. A few students read both values correctly but then performed the wrong calculation, usually adding instead of subtracting.

(b) Students scored poorly on this question. The few who gained full marks had a good understanding and their explanations were usually lucid. Most students had little understanding of the process, although a number managed to gain a mark for correctly identifying scale as calcium carbonate or recognising that a reversible reaction was involved. Many simply described the given equation in words and then assumed that calcium hydrogen carbonate, having been produced, must be scale, frequently attributing its formation to evaporation. Sometimes, explanations were undermined because students referred simply to ‘calcium’. A small number of students referred to the formation of scum.

(c) Very few students gained all four marks; the first marking point was very seldom awarded. Much was wrongly written about the reactivity of sodium causing it to react with Mg^{2+} and Ca^{2+} ions in a displacement reaction. There was also a problem with confusion of chloride with chlorine, resulting in answers referring to the sterilisation of water. Marks were frequently lost through students using loose terminology such as ‘sodium’ instead of ‘sodium ions’. Overall, however, many students scored at least two marks, usually for recognising that Mg^{2+} and Ca^{2+} ions are replaced, even if the source of the Na^{+} ions was not unambiguously given as the resin.

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

(a) (i) This was well done by many of the students, although there were frequent references to electronic structure in the explanation. Copper was identified much more frequently than hydrogen and the most popular correct explanation was that it is a transition metal.

(a) (ii) Approximately half of students answered correctly. The overwhelming majority of those who did not suggested the transition elements. There were a number who answered group 8 but frequently this was stated together with group 0 (i.e. Group 8/0) so the students were not penalised. A small number suggested the halogens.

(b) (i) Most students correctly identified one of the required elements. The most common wrong answers were from Group 4 (lead and tin) rather than Period 4, although there were also many seemingly random answers.

(b) (ii) Both marking points (atomic weight and properties) were awarded frequently but most students failed to gain both marks, concentrating on one or the other. Anachronistic predictions concerning atomic structure such as atomic number or number of outer electrons were common. A significant number of students did not answer the question correctly, explaining instead how Mendeleev knew there were missing elements and why he left gaps. Presumably they did not read the question carefully enough.

(c) (i) Majority of students were awarded a mark. Commonly rejected answers included suggestions that both lithium and sodium had just one energy level (shell), that they had the same, but unspecified, number of outer electrons, or made reference to their ions or reactivity.

(c) (ii) This was generally answered well. Most students are aware of the reasons for the difference in reactivity of lithium and sodium. Fewer students than normal omitted the comparative in one, two or all three of the statements. A few were penalised for not stating the word 'outer' in their answer. Some errors concerned the description of the electrostatic attraction as (electro)magnetic, gravitational, intermolecular, or as a bond.

Question 5 ***(Standard / High Demand)***

(a) **(i)** Just over half of students answered correctly. Incorrect answers in terms of pH or number of hydrogen ions were most common. A few lost the mark through imprecision of language, describing ethanoic acid as weakly ionising rather than weakly ionised.

(a) **(ii)** There was much confusion with the Brønsted-Lowry definition of an acid as a proton donor. Frequently, students tried to give both definitions, possibly not realising the significance of the difference. References were also made to pH or indicator colours and to hydrogen (rather than hydrogen ions) being either present in or produced by acids. A few students confused acids with alkalis.

(b) This question was generally well answered, with a quarter of students scoring a full four marks, and over half scoring three. Marks were most often lost by confusion regarding the indicator colour change, and to a lesser extent by leaving out a reference to the recording of volume (often too vague an instruction such as 'record results' was given) or by trying to titrate the vinegar with ethanoic acid instead of sodium hydroxide. Many students wasted time describing how to prepare the solution in the conical flask despite being given this in the question.

(c) **(i)** This was very disappointingly answered, with only a fifth of students being awarded the mark. The majority of students were able to calculate a mean correctly but did not take account of the anomalous result and arrived at an incorrect answer of 20.875.

(c) **(ii)** This proved to be a very demanding question for the majority of the students. Few were able complete the calculation correctly, and nearly a quarter gained no marks at all. The question asked the students to explain and most tried to give their answer in words rather than do a calculation. A number of students were able to calculate the concentration of the acid but were unable to carry on. Other students tried to work backwards, calculating number of moles of ethanoic acid in 5g, but were again unable to progress further. Less than a quarter of students did not attempt any answer at all. It seems that students are very poor at coping with unstructured calculations.

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