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General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Report on the Examination

2012 examination – June series

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Chemistry
Higher Tier CHY3H

General

The examination challenged less capable students, but the more able and better prepared were able to score well. A flexible mark scheme enabled students to gain credit for a wide range of chemical knowledge and understanding. Although many students wrote neatly and expressed themselves clearly, there were others whose subject knowledge and powers of expression were less secure.

The following questions were well answered by the majority of the students: 1(b)(i), 1(b)(ii), 4(a), 5(a)(i), 5(b)(i), 6(a), 7(a)(i) and7(b).

Question 2 on the history of the periodic table was generally poorly answered, and questions 5(b)(i) and 5(b)(ii) showed that while many students are familiar with the required chemical tests they have difficulty in interpreting results that challenge their understanding and logic. Question 7(a)(ii) also proved difficult for many students. There were fewer instances of un-attempted questions in this series.

It is still the case that the CHY3H Paper is being attempted by a significant number of students who find it extremely challenging. These weaker students would have been better suited to the Foundation Tier Paper (CHY3F).

Questions 1 and 2 were standard demand questions and were common with questions 6 and 7 on the Chemistry Foundation Tier Paper (CHY3F).

Question 1 *(Standard Demand)*

(a) The majority of students were able to identify magnesium (and often calcium) ions as the cause of water hardness, though many wasted time by describing how these ions got into the water. Many knew that the magnesium ions were removed by precipitation as solid magnesium carbonate. As a result, most students scored one or two marks. There was much confusion with ion exchange resins, but the process was not generally well described and there was a common misbelief that sodium ions displace magnesium ions because of a difference in reactivity. The omission of the word ‘ion(s)’ was common.

(b) (i) The majority of students answered correctly, although variations on the spelling of ‘anomalous’ and ‘anomaly’ were common.

(b) (ii) Only half of the students answered correctly. The principal incorrect answers were referring to evaporation rather than boiling, suggestions that as a pattern was already apparent there was no need to continue, and considerations of difficulty or safety, including the observation that people do not bathe in water at 100 °C.

(b) (iii) This question was answered correctly by almost all the students. Common wrong answers were 59 °C (wrong axis), 64 °C (misreading scale) and 74 °C (highest plotted point).

(b) (iv) This question was generally well answered although many students achieved only one mark by simply describing the graph without reference to the expected pattern. A major distraction was a belief that the graph should be curved, probably because such graphs are commonly referred to as ‘solubility curves’, although this term was not used in the question.

Question 2 *(Standard Demand)*

(a) Almost half the students gained one mark for high reactivity or reactivity with water; relatively few gained both marks. Students often described electronic structure without relating it to the ions formed, or cited physical properties. Others simply stated that the elements were the alkali metals or in Group 1.

(b) The most common mark awarded was one, with roughly equal numbers gaining either two or zero and very few being awarded all three. Students tended to focus either on the problems with Newlands' table or on the social aspects, thereby limiting themselves to a maximum of two marks. The scientific points were much more popular and generally well explained although some students lost a mark by referring vaguely to position without mentioning groups. The most common disallowed answer by far referred to a lack of gaps in Newland's table, anticipating Mendeleev.

(c) Two thirds of students gained a mark for the leaving of gaps. A good number went on to score a second mark but many confused cause and effect. It was often believed that gaps were left so that undiscovered elements might be included, students not understanding that the prediction of undiscovered elements was a result of gaps needed to make the patterns in the table coherent. A minority dwelt on the theme of atomic structure, and very few students mentioned the deviation from atomic mass.

Question 3 *(Standard / High Demand)*

(a) The majority of students gained at least one mark; approximately a third gained two. The most popular correct answers were malleability and low reactivity; hardness and strength were popular non-scoring answers, with students probably thinking of alloys rather than metals.

(b) This question was poorly answered, and those who did gain credit did so with varying amounts of clarity. Often marks were not gained because incorrect detail was provided such as 'the fourth shell holds two or three electrons'; this particular error appeared quite commonly, students recognising that transition metals fall between groups 2 and 3 and so assuming two or three outer electrons. Some spoke of shells 'overlapping' without going further. Many scored no marks because they described metallic structure and bonding instead of answering the question.

Question 4 *(Standard / High Demand)*

(a) The majority of students answered correctly. The most common incorrect answer was hydroxide.

(b) Most students gained least one mark, with a reasonable proportion scoring two. There was some confusion over pH scale with many thinking a stronger acid or higher concentration of hydrogen ions meant a higher pH. Some stated the pH difference without giving a reason whereas others explained strength in terms of dissociation into ions without comparing pH (presumably not noticing that the question required an answer as well as a reason). A few cited indicator colours rather than pH. As often in the past, some lost a mark through imprecise language, for example writing that in a strong acid the ions were more ionising.

(c) (i) Just over half of students answered correctly. A common fault was to write about phenolphthalein being used with a weak acid, omitting to mention a strong base. Some students wrote their answer the wrong way round; some talked about visibility of colour change.

(c) (ii) Approximately half of the students calculated the correct answer for two marks. Only a few scored a single mark for correctly calculating the number of moles of NaOH but being unable to proceed further; the rest failed to produce any creditworthy working.

(d) Fewer (approximately one quarter) gained both marks for this calculation, but a similar number gave an answer of 48 g, thereby gaining one mark.

Question 5 *(Standard / High Demand)*

(a) (i) Most students correctly described the limewater test for carbon dioxide and gave the correct result. A very small number mentioned limewater but omitted the result. A common error was to fail to notice that the question specifically asked students how to identify the gas produced from the addition of acid to a carbonate. As a result, many described tests for other gases such as for hydrogen or ammonia.

(a) (ii) Many students knew that test 3 was for aluminium but there was some confusion over whether the insolubility of the precipitate in excess sodium hydroxide argued in favour of or against aluminium ions. Of those who did score the mark relatively few went on to say that test three indicated magnesium or calcium ions to gain a second mark. The flame test was often cited, but usually incorrectly. Quite a few said that aluminium produces a red flame; others that it does not, but only a few gained a mark by correctly attributing the red flame to calcium (or lithium) or by indicating that aluminium produces no flame colour (which is not the same as ‘not red’). A few were incorrectly drawn to the test for nitrates by the mention of aluminium.

(a) (iii) There was some confusion with other tests but most identified test 4 as indicating the presence of chloride ions. Far fewer realised that the test was rendered invalid by the prior addition of hydrochloric acid and most of those who did unfortunately omitted to mention the test so that very few gained both marks.

(b) (i) Just over half of students answered correctly, mass spectrometry proving slightly more popular than atomic absorption spectroscopy. Wrong answers included incorrect instrumental methods such as nmr or uv but some gave wet chemistry answers such as flame tests. A few simply answered ‘spectroscopy’ without further elucidation. There is still confusion between spectroscopy and spectrometry along with much misspelling of these terms, but these were not penalised.

(b) (ii) Responses to this question were disappointing, with just under half of students being awarded a mark. Students frequently mentioned or described accuracy and, especially, precision. Such references did not gain a mark but, where cited in addition to a correct response, nor were they penalised.

Question 6 *(Standard / High Demand)*

(a) Most students answered correctly. The great majority of answers that did not gain credit were about the need for one more electron to fill the outer shell or referred to the same number of electrons in the outer shell without specifically identifying the number as seven.

(b) A significant number of students gained three marks with pleasingly clear explanations. Those scoring two marks usually did not give detail (e.g. omitting to mention *outer* electrons), or did not mention the essential point that an electron is gained (which is not the same as attracted). Even those with little understanding often knew that chlorine is the smaller atom. Of those who did score zero, a major cause was replacing the correct description with the equivalent but inverse arguments for the relative reactivity of alkali metals.

Question 7 ***(Standard / High Demand)***

(a) (i) Most encouragingly, the majority of students calculated the correct answer and obtained a full three marks. A common incorrect answer gaining two marks was 118, caused by counting two O-H bonds instead of four. Two marks were also frequently awarded for a single error in either bond breaking or bond making calculation followed by a correct subtraction. Elementary errors such as incorrect transcription, where a correct answer is wrongly copied onto the next line, are still common.

(a) (ii) As usual for questions on this part of the specification, there was much confusion over energy in and out, and careless language using the same for both e.g. less energy is needed to break bonds than to make them'. Many students ignored the instruction to give an explanation in terms of bond energies, for example by stating that more energy is given out than taken in but neglecting to state why.

(b) The majority of students answered correctly, mainly by mentioning activation energy. Some mentioned catalysts or lowering of activation energy. Some answered at an elementary level, quoting the 'fire triangle' by stating that a fire needs heat as well as fuel and oxygen.

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