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General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Report on the Examination

2011 examination – June series

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Chemistry
Higher Tier CHY3H

General

The examination challenged less capable candidates, but the more able and better prepared were able to score well. A sympathetic mark scheme enabled candidates to gain credit for a wide range of chemical knowledge and understanding.
The following questions were well answered by a vast majority of the candidates: Question 1(b), (c) & (d)(ii), Question 2(a)(i) & (ii), and Question 3(a) & (d).
The least well answered part of the Paper was 1(a)(ii), where only very few of the candidates gained all 3 marks and a minority gained 2 marks. Question 4(a) – explanation of an exothermic reaction in terms of bond making and bond breaking – proved testing for just over three quarters of the candidates, in part due to candidates' lack of care with use of English.
It is pleasing to note that far fewer parts of questions were left blank and only parts 5(a)(ii), 5(b)(iv) and 6(b) were left blank by only few of the candidates.
It is clear that the CHY3H Paper was not appropriate for relatively few of the candidates. These weaker candidates would have had a less than positive experience and would have been better suited to the Foundation Tier Paper (CHY3F).
Questions 1 and 2 were standard demand questions and were common with Questions 5 and 6 on the Chemistry Foundation Tier Paper (CHY3F).
This Report should be read in conjunction with the published Mark Scheme.

Question 1 ***(Standard Demand)***

(a) (i) About a third of the candidates scored both marks by calculating 100 and 30 correctly. Many managed to gain 1 mark by stating all the amounts for calcium and magnesium as shown on the labels. However, about half the candidates gained no credit, they usually just restated the information given in the stem of the question - that *Mountain View* had 3 times the amount of calcium and magnesium. Some candidates noticed that 21 is 3 x 7 and assumed that sulfate ions cause hardness.

(a) (ii) This was the least well answered part of the paper. Very few of the candidates gained all 3 marks and just under a vast minority gained 2 marks. Just under half of the candidates scored nothing. The vast majority of the candidates simply 'added' or 'used' soap solution without stating that some sort of agitation was needed. Although many candidates recognised that *Mountain View* would produce more scum or require more soap to lather, a large number did not make their prediction quantitative. Others thought that 3 times the lather would be produced or that it would take 3 times as long to form the lather. Candidates frequently did not gain the 'fair test' mark because they used equal amounts of each type of water **and** equal amounts of soap solution. Many weaker candidates described washing hands using the spring waters and equal sized bars of soap!

(b) This was well answered by a vast majority of the candidates who usually wrote about calcium, heart disease or strong bones and teeth. Some candidates thought that hydrogencarbonate or sulfate ions were important. Others suggested that hard water contains essential ions, minerals or vitamins.

(c) The disadvantages of hard water were known by most of the candidates. Many candidates confused scale and scum – scum does not form in kettles or pipes, and neither does hard water itself block pipes!

(d) (i) About a third of the candidates gained credit for recognising that everything including water was a chemical, or that water contains the chemicals listed on the labels. The majority of the candidates missed the point of the question and there were two major causes of confusion. Many thought that the water was unsafe to drink because chlorine had not been added and therefore the water still contained bacteria. Others answered in terms of how science works and mentioned bias because the claim was made by the company selling the water

(d) (ii) A very well-answered question with nearly all of the candidates gaining credit. Those who did not, tended to answer in terms of reliability or the results not being verified by other scientists but they missed the point that the company scientists might be biased. It is disturbing that the majority of candidates seem to think that the Company is biased rather than may be biased.

Question 2 *(Standard Demand)*

(a) (i) Most candidates gained credit and mentioned barnacles, seaweed or both. Those that did not, generally identified differences in density, melting point, reactivity or toxicity as the reason for using copper. Some candidates did not gain credit because they used the word ‘it’ to mean the wrong metal and others did not use the information given.

(a) (ii) Most of the candidates recognised that Muntz Metal cost less. Some wrote about Muntz Metal being an alloy. Again, some candidates were let down by an ambiguous use of the word ‘it’.

(b) (i) Half of the candidates correctly answered this question. The most common incorrect responses included titrations, electrolysis, chromatography, flame tests, using a magnet and incorrect types of spectroscopy.

(b) (ii) A third of the candidates gained credit for mentioning the precision/sensitivity of instrumental methods, or the ability of instrumental methods to detect small amounts. Some candidates are unaware of the difference between accuracy and precision. Common incorrect responses involved the reactivity (or lack of reactivity) of iron, and the presence of other metals masking the results of chemical tests. Many candidates just repeated what was said in the question – that the metal contained only small amounts of iron – and gained no credit.

(c) This was generally well answered. Most students gained at least 1 mark, usually for strong or hard. The most popular unaccepted answers concerned irrelevant properties such as density and melting point. Vague words such as ‘durable’ were common, as were references to cost. There was some confusion between the words ‘corrode’ and ‘corrosive’. Many candidates were unable to spell ‘malleable’.

Question 3 *(High Demand)*

(a) Most candidates gained credit for mentioning the Noble Gases or the transition elements. A common incorrect response involved candidates writing ‘Group 0’ or ‘Group 8’ and then adding ‘Halogens’.

(b) Candidates were aware that the position of these elements was reversed because their properties did not fit the original groups but poor powers of expression meant that they often did not gain credit. There were vague references to fitting (or not fitting) a pattern, or 'because they matched up with those around them'. Other candidates simply referred to atomic (proton) number or outer electron configuration, apparently unaware that atomic structure was unknown in 1869! Just under half of candidates scored the mark.

(c) While the majority of candidates gained at least 1 mark, only a very small minority gained all 3 marks. Many candidates realised that Mendeleev mixed metals and non-metals <u>in the same group</u>, and that there were two elements in more than one box. Saying that Mendeleev mixed solids/liquids/gases in the same group received no credit. Most candidates were aware that Mendeleev left gaps, and that he had reversed the order for some elements. However, simply stating that all the elements had not been discovered is **not** the reason why chemists disagreed with Mendeleev! Very many candidates mentioned Mendeleev's youth, low status in the scientific community and lack of expertise, or referred to lack of evidence/proof, the religious beliefs at the time or that other scientists were jealous! Some even suggested he wasn't a proper scientist because he was only a chemist! In 1869 neither Mendeleev nor his peers would have been aware of modern atomic theory, so any discussion would not involve protons, electrons, etc. Clearly teachers have some issues to address here.

(d) This question was well answered by the majority of candidates. There continue to be references to 'outer shell *atoms*' and elements having '*more* outer shells'. A minority of candidates confused groups/columns and periods/rows.

Question 4 *(High Demand)*

(a) This question was answered better than in previous years and about a quarter of the candidates gained credit. However, the majority of candidates continue to have difficulty expressing their ideas clearly and accurately and precisely without contradiction. Once again, a very common error was the suggestion that 'less energy is needed to break bonds than to make them'. It is a difficult concept for candidates to understand that bond formation releases energy because it *seems* logical that an input of energy is needed when something is made. Many candidates think the answer is to do with the *number* of bonds broken/formed. There were also many meaningless statements such as 'bond making is higher than bond breaking'.

(b) (i) Over three-quarters of the candidates successfully used the diagram to explain why the reaction was exothermic. A popular misconception was that energy change **B** shows that heat is evolved.

(b) (ii) Just over half the candidates knew that energy change **B** (activation energy) must be high. Candidates who gained no credit often suggested that 'it took a long time to reach the energy change' or that 'activation energy uses a lot of energy'.

(b) (iii) The majority of the candidates knew that manganese(IV) oxide was a catalyst but fewer explained that it lowers the activation energy or provides a lower energy pathway even though they recognised that a catalyst provides a surface upon which the reaction takes place. Many candidates think a catalyst supplies energy or that less heat is given off if a catalyst is used. A significant number of candidates were penalised because they referred to the catalyst as magnesium or magnesium oxide – some even giving an explanation in terms of the reactivity series. Candidates should also be aware that 'manganese' is not the same substance as 'manganese oxide', and that they should use the correct names for chemicals and similarly if they use the formula of a compound it should be the correct formula.

(c) While a majority of the candidates realised that the lower temperature was due to heat loss, only a quarter stated that this was due to lack of insulation. Many candidates incorrectly suggested that a catalysed reaction produces less heat or attributed the lower temperature to a lowering of the activation energy. Some even suggested the catalysed reaction was too quick, so there wasn't enough time to heat up the water!

Question 5 *(High Demand)*

(a) (i) Half the candidates knew that ammonia turned red litmus blue and gained 2 marks. Some candidates think that ammonia bleaches litmus, or that it turns blue litmus red. A significant number thought the test for ammonia was to smell it! Candidates had to make clear in their answer that it was not the sodium hydroxide solution that was being tested. Candidates who used incorrect reagents, such as hydrochloric acid or Devarda's Alloy/aluminium, gained no credit.

(a) (ii) Just under a half of the candidates knew the test for a sulfate. Candidates should be aware that barium is not the same substance as barium chloride, and that BaCl is not the formula of barium chloride. Other incorrect reagents included sodium hydroxide, silver nitrate, bromine water, barium sulfate and hydrochloric acid (without the barium chloride). Weaker candidates suggested using flame tests. Some candidates did not give a reagent but just suggested that a white precipitate was formed on the off-chance that credit would be given! It was not.

(b) (i) More than half of the candidates correctly explaining the meaning of *strong* in terms of being completely or fully ionised. The concept has nothing to do with "ions ionising", the acid/base ionising other substances, dilution/concentration, the number of ions formed or the speed of ionisation.

(b) (ii) About half the candidates correctly identified 'methyl orange' as a suitable indicator for strong acid-weak alkali titrations. Incorrect 'indicators' included phenolphthalein (sic), litmus, universal indicator, bromine water and limewater.

(b) (iii) It is pleasing to see that candidates are gaining in confidence with this type of calculation – a minority of candidates gained 3 marks, 2 marks respectively (they usually ignored the mole ratio factor of 2). Good candidates organised their calculation clearly and logically while weaker candidates lacked the basic skills to do so.

(b) (iv) About a half of candidates gained credit for calculating the concentration of the ammonia solution in grams per cubic decimetre. Weaker candidates divided by 17 or divided their previous answer by 17. Some candidates felt the 17 should be multiplied by 2 and used 34 in their calculation, while others did not use either their answer from part (iii) or 0.15.

Question 6 *(High Demand)*

(a) (i) Over half the candidates knew that bromine water was decolourised by unsaturated organic compounds. Candidates who simply suggested that bromine water turns ‘clear’ gained no credit – the word ‘clear’ means ‘transparent’, not ‘colourless’. Other unsuccessful candidates thought the colour of bromine water was unchanged or said that there was a colour change without mentioning it went colourless.

(a) (ii) Just under half the candidates successfully identified double or triple bonds as the key factor. However, many candidates must think that because the prefix ‘un-’ means a *negation*, so ‘unsaturation’ must mean ‘no double bonds’! Some candidates had not appreciated the context of the question and referred to solubility and unsaturated solutions.

(b) More than half of the candidates were able to achieve 2 or 3 marks for this calculation. The most common mistakes were: (1) calculating the correct number of moles of H_2O and CO_2 but then giving the empirical formula as CH; (2) arriving at the correct empirical formula by calculating the correct number of moles of C and H but without giving the number of moles of water as required in the question; (3) recognising that the empirical formula CH_2 is not a feasible molecule and then proceeding to give some multiple of it such as C_2H_4; (4) using M_r/mass instead of mass/M_r to find the number of moles.

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