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General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Report on the Examination

2009 Examination – January Series

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Chemistry
Higher Tier CHY3H

General

This was the third examination of the new Specification.

While most candidates had been entered for the correct Tier, it appeared that there were a significant number of candidates who were insufficiently prepared for this examination. They perhaps would have been better suited to the Tier F Paper or even should have been entered for the examination later in the academic year (in June) once they were better prepared and gained in maturity.

Although many candidates wrote neatly and expressed themselves clearly, it was noticeable that there were others whose subject knowledge and powers of expression gave cause for concern.

A sympathetic mark scheme enabled candidates to gain credit for a wide range of chemical knowledge and understanding. The following questions were answered well by the majority of the candidates: Question 1 part (b), Question 2 (except for the last part), Question 3 (a) and (b)(i), Question 4 (a) and Question 6 (b).

However, the following questions proved particularly difficult for over 60% of this cohort of candidates: Question 2 (g) (energy diagram), Question 4(b) (why Döbereiner's ideas were replaced by those of Mendeleev), Question 4(d)(ii) (why transition elements have similar properties), most of Question 5 (acid/base theory), Question 6 (a) (test for unsaturation) and Question 6 (c) (distinguishing C_3H_8 and C_4H_{10} by mass spectrometry).

Other questions that were poorly answered by at least 45% of these candidates were: Question 1 (a) (chemical analysis) and Question 6 (d) (empirical formula calculation).

Many of the questions that were less well answered tended to be those involving specific knowledge that had to be learned, and those that required careful explanations and the use of specific scientific terminology. Candidates do need to make the effort to learn the factual material given in the Specification carefully and be more careful in their use of English.

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

This Report should be read in conjunction with the published Mark Scheme.

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

In part (a)(i) a surprising number of candidates did not know the test for carbonates. Many used silver nitrate, sodium hydroxide or flame tests, and some thought carbon was evolved. Many candidates knew that carbon dioxide was involved in some way but too many simply added the limewater to the carbonate. Carbon dioxide forms a white precipitate with limewater.

Many candidates in part (a)(ii) lost marks by describing an incorrectly coloured precipitate – cream and yellow were common errors.

In part (a)(iii) many candidates had difficulty expressing themselves, and those candidates who stated the colours frequently gave the wrong colours. Potassium was sometimes suggested to give a red or a white flame test rather than lilac.

Both parts in (a) were well answered and it was clear that generally candidates understood the issues and gave very sensible and mature answers.

Part (b)(i) was well answered - most candidates were able to suggest a reason why Option 1 was rejected.

In part (b)(ii) the majority of the candidates could extract the information for the advantages of Option 2 from the passage. However, identifying the disadvantage was problematic for many who focused on the difficulty of removing salt from food and quoted economic factors in their response. Taste, flavour and preservation were the correct responses most often seen.

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

Apart from part (g) this question was well answered by the candidates.

Most candidates in part (a) made sensible suggestions about insulating the beaker to reduce heat loss. Several candidates were unaware that bomb calorimeters are used to measure enthalpies of combustion rather than enthalpies of neutralisation.

In part (b) the idea that the chemicals were stirred to mix them thoroughly and ensure a complete reaction was well known. Typical vague responses included “so they react properly” and “to get the correct results”.

Many candidates in part (c) identified experiment 4. Of those candidates who correctly identified experiment 2, a significant number were less than precise with their reason, making only some vague reference to the results rather than the initial temperature.

Part (d) was very well answered, although many candidates were again less than precise with their language and referred to results rather than temperature change. While many different spellings of “anomalous” often gained credit, the mark scheme did not extend to “enormous” or “miscellaneous”.

Parts (e) and (f) were very well answered.

Calculating the average proved difficult for some candidates but they usually gained credit in part (f) with the help of consequential marking.

Only just over a third of the candidates in part (g) gained credit for this part. However, most candidates chose diagram B and some of them then went on to give the correct reason. Candidates appeared to confuse temperature increase and energy decrease.

Question 3 ***(Standard Demand)***

Most candidates in part (a) gained 2 or 3 marks for describing the water cycle. "Condensation", or a description of it, was frequently omitted. The majority of candidates stated more than one of the marking points associated with the 3rd mark. However, there was a wide variation in the standard of English used by candidates in their descriptions. Some candidates mistakenly thought that the water cycle was to do with water treatment (screening, filtering, flocculating and sterilising).

In part (b)(i) Most candidates knew that calcium or magnesium ions were responsible for water being hard. Chloride, nitrate and sodium ions were the usual incorrect responses. Candidates who did not name an ion (as asked for in the question) but gave a symbol that was incorrect (e.g. Ca^{+}) gained no credit.

Once again in part (b)(ii), candidates continue to use inappropriate terminology such as the water flows over the "ground" and "picks up" the ions, points that have been identified many times over the years in Examination Reports as being inappropriate. Many candidates appear to be unfamiliar with the word "dissolve" or "soluble".

It was clear from the responses in part (b)(iii) that the chemistry of the process was not understood by many candidates who often gave a confused account. Many candidates mentioned ion-exchange, wrote about sodium carbonate ions or negated a key word (e.g. displace) by a contradictory or incorrect statement. Those candidates who realised that calcium and/or magnesium carbonate was formed, often failed to state that these carbonates were insoluble.

Question 4 ***(High Demand)***

In part (a) most candidates were able to explain why calcium, strontium and barium were a triad. Common incorrect responses were based on atomic number or similarity of chemical reactions.

Far too many candidates in part (b) focused on Mendeleev and wrote about him leaving spaces for new elements.

In part (c) This part was answered very well. A few named the products rather than described what is seen.

Part (d)(i) was well answered by most candidates. The common error was to omit a reference to the outer shell of electrons.

In part (d)(ii) this was the second poorest attempted question on the paper. There was little appreciation that transition elements (generally) have the same number of outer shell electrons or that an inner shell was being filled. Many candidates had vague ideas about overlapping shells and stated a variety of numbers of electrons in the outer shell - even suggesting it was full. Other candidates based their explanations on physical properties, particularly conductivity and delocalised electrons. The term orbital has a specific meaning in chemistry and is not equivalent to shell, orbit or energy level.

A majority of candidates in part (d)(iii) were able to gain credit for explaining why lithium is less reactive than potassium, although many preferred to explain why potassium is more reactive than lithium! In a question such as this, a comparison is required so it is essential to include comparative terms such as more, closer, stronger or easier. Simply saying easy, close or strong is insufficient. Candidates should be careful not to say that lithium has "fewer outer

shells" when they mean "fewer shells". A significant minority of candidates still persist in writing about magnetic, gravitational or bonding attractions, and did not gain the second marking point.

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

This question discriminated well between the candidates. As mentioned in previous Examination Reports, this area of the specification is poorly understood and requires careful teaching.

Many candidates in part (a)(i) appeared unaware that the Arrhenius theory was about ions and wrote about protons. Others attempted to hedge their bets and wrote about hydrogen ions (H^+) and protons donors!

Part (a)(ii) was less well known than part (i). Some wrote about proton acceptors or mentioned hydride ions (H^-) or oxide ions (O^{2-}) rather than hydroxide ions (OH^-).

Many candidates in part (a)(iii) found this part challenging. Many wrote about hydrogen and oxide ions being balanced while others referred to the balancing of the charges on the ions. Good candidates wrote about hydrogen ions being neutralised by hydroxide ions or mentioned that there were equal amounts of these ions.

In part (b) many candidates did not appreciate that Brønsted and Lowry defined an acid as a proton donor. Some candidates again hedged their bets and wrote about protons donors and hydrogen ions (H^+), while others referred to substances with a low pH or wrote about weak/strong acids.

Part (c) was the best attempted part of question 5. Many candidates believed that Arrhenius had *no* evidence or proof, rather than *little* or *less* evidence/proof.

Question 6 ***(High Demand)***

In part (a) the test for unsaturation was less well-known than usual. While many candidates recognised that the reagent was bromine, too many candidates did not understand the difference between *clear* (i.e. transparent) and *colourless* (i.e. having no colour). Some candidates thought bromine remained unchanged if unsaturated chemicals were present. Other incorrect tests seen included the use of bromide, hydrogen, burning and flame tests.

Part (b) was well attempted by the majority of the candidates who realised that the smell would alert people to the presence of the gas if there was a leak.

Part (c) was the worst attempted question on the Paper. Mass spectrometry was poorly understood by most of the candidates, and there were many references to atomic mass (rather than molecular/formula mass), isotopes and elements.

This part seemed to discriminate well. About half of the candidates in part (d) were able to gain some credit on this question. The first two steps in the calculation were generally done well. However, the translation that 1 mole of carbon dioxide is equivalent to 2 moles of water and hence 4 moles of hydrogen proved challenging for many.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the **Results Statistics** page of the AQA Website.