AS

Chemistry

7404/1 Inorganic and Physical Chemistry

Report on the Examination

7404
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General

This examination of the AS specification highlighted some key points about students' performance that may prove useful.

Students need to:

- be very familiar with all the practical procedures contained in the specification and, very importantly, understand why they carry out the procedures that they do in practical work, rather than just know what to do
- be able to write ionic equations
- be able to combine half-equations to deduce overall equations for redox reactions
- be encouraged to set out working with a clear explanation of each step in a calculation rather than just writing down a set of different numerical expressions
- be able to give answers to calculations to appropriate precision based on the precision of the data in the question
- make sure that they refer to the stoichiometry in reactions when completing extended mole calculations.

Section A
Question 1: Halide Ions

01.1 Many students were able to identify the halide ion present in **Q** as iodide, but only about a quarter of students were able to give the correct ionic equation for the reaction of these ions with bromine. Common incorrect answers gave equations that included the spectator ions and also half equations that showed the reduction of iodide ions.

01.2 This question was not well answered. Many students did not mention oxidising ability. Students need to be precise with their use of terminology and understand that halogens are displaced, and halide ions are oxidised. Commonly students included incorrect statements such as 'bromine is not able to displace chloride' or 'bromine is unable to oxidise chlorine.'

01.3 Many students were able to describe a suitable chemical test using ammonia. However, most students were unable to describe how the observations can be used to identify the halide ion present in **P** and the halide ion present in **R**. Students often suggested incorrectly that the solutions or ions dissolved rather than the precipitates.

Question 2: The elements of Group 2

02.1 This question was well answered, and most students were able to explain that the third electron was being removed from the 1s orbital.

02.2 This question was also well answered by many students. Some students, however, did not refer to the products formed in their answers. Reference to the differing rate of reaction was a common difference mentioned by students. The comparison required reference to the products, so this difference was not awarded credit.

02.3 Students did not always answer the question and explain, in terms of oxidation states, the redox characteristics of the reaction between calcium and water. Instead, they just identified the oxidising agent and reducing agent. A few students attempted to explain the redox chemistry of this reaction in terms of loss and gain of oxygen and/or hydrogen.

Question 3: Structure and Bonding

03.1 The definition of electronegativity was well known by students although a few did not refer to covalent bonds in their answers.

03.2 Most students understood that the atoms had different electronegativities but then many did not go onto explain why this difference causes polarity within a bond.

03.3 The majority of students realised that the symmetry of the molecule led to the molecule being non-polar. However, only a few students were able to explain that this means that the dipoles cancel out. A large number of students incorrectly stated that the polar bonds would cancel out or that the partial charges cancelled.

03.4 Students generally gave good explanations of what causes van der Waals' forces, although many did not always explain that dipoles are induced in neighbouring molecules or that the induced dipoles cause molecules to attract each other.

03.5 Most students understand that barium oxide contains Ba^{2+} and O^{2-} ions. However, fewer students were able to draw a cubic 3D lattice with alternating ions.

Question 4: Analysis of solutions

04 Only a few students scored all the marks on this question. Inorganic ion tests were not well described. In particular, many students did not show that the test for ammonium ions requires the use of sodium hydroxide as well as placing damp red litmus paper at the top/mouth of the tube. Students did not always provide any equations for these tests and when these were provided, they were often not ionic equations.

Question 5: Shapes of molecules and ions

05 About a quarter of students scored all the marks on this question. However, students did not always justify the octahedral bond angle by stating that all the bonding pairs of electrons would repel equally. A good number of students also stated that SF_3^+ was trigonal planar or trigonal bipyramidal rather than it being pyramidal.

Question 6: Atomic structure and mass spectrometry.

06.1 This question on electron configuration was well answered with over three quarters of students scoring this mark.

06.2 This question was not well answered by students. Rather than giving an equation to form a molecular ion that would have been produced during electron impact ionisation, students often gave equations to form Br^+ or Br^- ions.

06.3 Students did not always label the axes on the Figure, and often the x-axis was labelled M_r rather than m/z. Students generally realised that there would also be a peak at $m/z = 162$ due to the Br_2^+ ion where both bromine atoms were ^{81}Br, but only about a quarter of students realised that there would be a Br_2^+ ion that contained one atom of each isotope, so would have $m/z = 160$ and that this ion would be twice as abundant as the ion that produced the $m/z = 158$ peak.

06.4 The majority of students did not appreciate that the relative abundance of the ion would be proportional to the size of the current in the detector. Common misconceptions included suggesting that speed or time of flight was linked to abundance.

Question 7: Percentage by mass of MgO in some tablets

07.1 About one third of students realised that the mass of the tablets was determined by taking two readings on the balance and so the uncertainty in the mass should be doubled.

07.2 Very few students appreciated that appropriate precision in this answer would be three significant figures because the data provided is all given to three significant figures.

07.3 This was a challenging calculation with only about a quarter of students scoring all the marks. Students did not realise that excess hydrochloric acid was used in the reaction with the tablets and so they needed to calculate the amount, in moles, of hydrochloric acid that reacted with the tablets by subtracting the amount, in moles, of hydrochloric acid that was neutralised by the sodium hydroxide solution from the initial amount, in moles, of the hydrochloric acid used. Also, students did not always appreciate that two moles of hydrochloric acid react with one mole of magnesium oxide because they did not apply the stoichiometry of the equation to the calculation.

Question 8: Silver nitrate

08.1 Around a quarter of students were correctly able to define the standard enthalpy of formation. Students did not always state that one mole of substance was being formed and also did not state that all substances should be in their standard states.

08.2 This calculation was generally done well although only slightly over a third of students realised that there were two moles of $AgNO_2$ in the equation and so the value of their answer should be halved.

08.3 Students found this challenging with a very small number appreciating that it is not possible to measure the temperature of a solid, or that it was not possible to measure the temperature change of a reaction that is being heated.

08.4 Most students scored some marks on this question, although only about a fifth of students correctly identified three different inaccuracies and three improvements. Students generally focussed on the use of the measuring cylinder, the glass beaker, and inaccuracies in the initial and/or maximum temperature in this reaction. Some students incorrectly suggested that washings should be added and that repeating the experiment would improve accuracy.

Question 9: Redox Reactions

09.1 The definition of the term oxidising agent was well known, and this mark was scored by more than three-quarters of students.

09.2 The half-equation to show the oxidation of copper was well answered although the most common mistake was for students to add electrons to the wrong side of the reaction.

09.3 Although well over half of the students gave a correct half-equation, other students did not always balance the hydrogen atoms which led to an incorrect number of electrons.

09.4 Students did not always multiply the half-equation from 09.3 by two to allow the electrons to cancel out when the two half-equations were combined.

Section B

Question 10: Atom Economy
About two-thirds of students (65%) were able to correctly calculate the atom economy for the reaction.

Question 11: Dative Covalent Bond
Just over half of students (57%) were able to identify the reaction in which a dative covalent bond is formed.

Question 12: Mean titre
The majority of students (80%) were able to calculate correctly the mean titre using the data from the table – ignoring the non-concordant titres.

Question 13: Reaction of chlorine with water
Students found this question challenging with significantly less than half (38%) able to indicate which species cannot be formed during the reactions of chlorine with water.

Question 14: Properties of Group 2 elements
Just over half the students (55%) could identify the correct statement about the properties of Group 2 elements. A large number of students incorrectly thought that magnesium oxidises titanium(IV) chloride in the extraction of titanium.

Question 15: Melting points of Period 3 and Group 2 elements
Only about 40% of students were able to identify that potassium has the lowest melting point, with many students (about one third) incorrectly choosing sodium.

Question 16: Trend in physical properties of Period 3 elements
This question was well answered with over 60% of students identifying the correct trend in atomic radius and in first ionisation energy across Period 3.

Question 17: Stoichiometry
The majority of students (85%) correctly balanced the equation.

Question 18: Empirical Formula
This was well answered with about three-quarters of students able to determine which oxide of chlorine contains 42.5% by mass of chlorine.

Question 19: Reducing ability of halide ions
Although just over half of students could identify which sodium halide does not reduce concentrated sulfuric acid, a large number (about one third) incorrectly thought that sodium astatide does not reduce concentrated sulfuric acid.

Question 20: Time of flight mass spectrometry
About two-thirds of students were able to identify which sample gave ions with the shortest time of flight.

Question 21: Atomic Structure
This question was well answered with the majority of students (82%) identifying the correct isotope.

Question 22: Second ionisation of Mg
Nearly all students (over 90%) were able to correctly identify the equation that shows the process that occurs during the second ionisation of magnesium.

Question 23: Titration accuracy
A good number of students (about 60%) were able to identify the step that would improve the accuracy of a titration.

Question 24: Electron configuration
Students found this challenging with just over one third of students able to identify the atom that has the greatest number of unpaired electrons.

Mark Ranges and Award of Grades

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