AS LEVEL
CHEMISTRY

7404/1 Inorganic and physical chemistry
Report on the Examination

7404/1
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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 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;
- understand how to convert numerical values to take into account different units;
- make sure that they refer to the stoichiometry in reactions when completing extended mole calculations.

Section A

Question 1: The elements of Period 3

01.1 Many students were able to give the full electron configuration of the element in Period 3 with the highest first ionisation energy. However, some students provided electron configurations for Period 2 elements or for sodium/chlorine rather than for argon.

01.2 This question was well answered with over two-thirds of students scoring the mark. However, the state symbols in the equation were sometimes missing. This was the most common cause of error.

01.3 Students found this question more challenging. Whilst most were able to identify that a large jump between successive ionisation energies was important, the reason for this large jump was not always clear. Students did not always explain that the electron removed was closer to the nucleus. Another common cause of error was the incorrect statement that the large jump in ionisation energy was due to pairing of electrons.

Question 2: The elements of Group 2

02.1 Students did not always describe both the structure and bonding in magnesium. In particular, students did not describe the particles between which there is an attractive force.

02.2 This question was well answered, although students didn't always consider the change in the number of electron energy levels in the atoms.

02.3 Students found this question challenging and did not always include state symbols in their equations. Some students incorrectly gave $Mg(OH)_2$ as the product of this reaction, whilst common incorrect observations included fizzing and the formation of a precipitate.

02.4 Just over half of the students achieved both marks on this question, although some students gave the formula of a sulfide rather than a sulfate and the uses given were often uses of calcium hydroxide or magnesium hydroxide rather than barium sulfate.

02.5 Just over half of the students scored all the marks on this calculation. However, a common cause of error was that some students did not realise that the combined abundance of ^{87}Sr and of ^{86}Sr was 17%.

02.6 This was a challenging calculation with only about a third of students scoring all the marks. Students did not always apply the stoichiometry of the equation and used incorrect M_r values for $Mg(OH)_2$. They also did not always appreciate that it was the excess of hydrochloric acid that reacted with the sodium hydroxide and that they could use this to determine the amount of hydrochloric acid that reacted with the $Mg(OH)_2$ in the tablets by subtraction.

Question 3: Standard solution of sodium carbonate

03.1 This was a challenging question. Some students mentioned changes to the apparatus rather than changes to the method used. Students were not always clear with their improvements to the method. Any discussion of washing should include an indication of where the washings were going. Most students understood that it is the bottom of the meniscus that should be level with the graduation mark rather than the top of the meniscus.

03.2 This was well answered by students with about three-quarters scoring the mark. Doubling the uncertainty was the most common error.

Question 4: Identity of M in $M(NO_3)_2$

04 Students should 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. There were a number of incorrect rearrangements of the ideal gas equation and incorrect unit conversions. Also, a good number of students did not use the equation stoichiometry.

Question 5: Shapes of molecules

05 Just under a quarter of students scored all of the marks in this question. However, students did not always refer to electron pair repulsion theory when explaining the shape and bond angle in each molecule. Whilst most knew the name of the shape of CF_4, fewer students were able to give the correct name for the shape of XeF_4.

Question 6: Halogens and halide ions

06.1 Only about a quarter of students scored both marks on this question. Students generally referred to the attraction for outer electrons rather than the attraction for the bonding pair of electrons.

06.2 The observations for these reactions were not well known. There appeared to be some confusion between the reactions of sodium halides with silver nitrate solution and the reactions of sodium halides with concentrated sulfuric acid, so many students incorrectly mentioned the formation of white and/or cream precipitates.

06.3 Students found writing the half-equation for the reduction of concentrated sulfuric acid to hydrogen sulfide challenging. In the overall equation students did not always cancel down the electrons.

Question 7: Time of flight (TOF) mass spectrometry.

07.1 This was found to be a challenging calculation with only a few students realising that in electrospray ionisation a proton is gained by the molecule; so to determine the M_r of the molecule, 1 should be subtracted from the mass of one mole of ions as measured in the mass spectrometer. Other common causes of error included not correctly determining the speed of the ions by dividing the length of the flight tube by the time of flight and also when converting the mass of one ion to the mass of one mole of ions.

07.2 Just over half of the students achieved the mark on this question. A common error was that students did not explain that one electron had been knocked off each molecule.

07.3 The main cause of error in this question was that students did not identify an ion but rather just gave the formula of a molecule.

07.4 When describing how the ions are detected in a TOF mass spectrometer, students need to explain how the current is produced. Students didn't always know how the abundance of each ion is measured. They should explain that the abundance is proportional to the size of the detector current – many students just referred to the abundance being determined by a computer.

Question 8: Chemical equilibrium

08.1 Just over half of the students scored both marks in this question. However, many students did not deduce the amount of **A** remaining at equilibrium by subtracting the amount of **C** formed from the initial amount of **A**. Another common cause of error was assuming that the amount of **B** was always twice the amount of **A**.

08.2 This was well answered by the majority of students. However, the expression for the equilibrium constant, K_c, needs to be in terms of [A], [B] and [C] rather than with values.

08.3 Students did not always answer in terms of Le Chatelier's Principle. Students need to make sure that they make reference to a shift in the position of equilibrium.

08.4 Just over half of the students scored all the marks on this question. Common causes of error included some incorrect rearrangements for the expression for the equilibrium constant and answers that were not always given to the appropriate number of significant figures.

Section B

Question 9: Atomic Structure
The vast majority of students (86%) were able to deduce correctly the atom that contains the most neutrons.

Question 10 and Question 11: Titration
About half of the students scored the mark on these questions. In question 10, some students decided, incorrectly, that rinsing the conical flask with vinegar (one of the reagents) between each titration would improve accuracy. In question 11, a number of students decided that rinsing with distilled water would decrease the percentage uncertainty.

Question 12: Atom Economy

The majority of students (68%) were able to deduce which equation had the highest atom economy for the production of hydrogen.

Question 13: Dipoles

About half of the students were able to identify the molecule that has a permanent dipole.

Question 14: Coordinate Bonds

Just under half of the students were able to identify the molecule that can accept an electron pair during the formation of a coordinate bond. A common incorrect answer was the identification of a molecule that would donate the lone pair during the formation of a coordinate bond.

Question 15: Standard enthalpy of formation

About two-thirds of students correctly identified the reaction that has an enthalpy change equal to the standard enthalpy of formation of potassium oxide.

Question 16: Oxidation states

This was well answered with the great majority (82%) of students correctly identifying the species with chlorine in its highest oxidation state.

Question 17: Redox reactions

Students found this question challenging with less than half correctly understanding the redox processes in this reaction.

Question 18: Half-equations

This was well answered with nearly three-quarters of students correctly choosing the half-equation that can be balanced by two H^+ ions and one electron.

Questions 19 to 23: Test-tube reactions

These questions enabled students to analyse and interpret some observations from some test-tube reactions. They were generally well answered by students, although they found it more challenging to deduce the identity of the compound in solution **P** in question 20, and of the compound in solution **T** in question 23.

Question 22

Unfortunately there was a typographical error in option B, where silver iodide (AgI) was mistakenly shown as Ag. In order to mitigate possible disadvantage to students, the question was discounted and every student received a mark for this question.

To avoid any chance of a similar error happening in future, it has been decided that, from 2024 onwards, iodine/iodide will be represented by a very clear capital (Times New Roman font) I.

Mark Ranges and Award of Grades

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