AS LEVEL
CHEMISTRY

7404/1: Inorganic and Physical Chemistry
Report on the Examination

7404
June 2022

Version: 1.0

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;
- recall the tests for inorganic ions;
- show working out clearly, with a clear explanation for each step of their calculation;
- understand how to convert numerical values to take into account different units;
- ensure that all chemical equations are balanced for both atoms and charge.

Section A

Question 1: Ionisation Energies of Group 2 elements

01.1 Many students were able to explain why the first ionisation energy decreases down the group, although it is important that students make reference to the outer electron in their answers rather than just electrons in general.

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

01.3 Students found this question more challenging with many concluding that the electron was being removed from a full electron shell rather than discussing the idea that the outer electron was being removed from a lower energy level. Few answers discussed the effect of the change in shielding on the attraction for the outer electron.

Question 2: Acid-Base titrations

02.1 A high number of students were able to describe accurately how to weigh out an accurate mass of solid into a beaker, although students often went on to describe how to make up a standard solution. Answers which just stated "weigh by difference" were not sufficient without a description of how this can be achieved.

02.2 The calculation of the concentration of a solution was completed well. Common errors in this calculation included the use of an incorrect M_r value or incorrect rearrangement of the relationship between moles, volume and concentration.

02.3 Students did not always identify mistakes in the method given, but when these were identified students were usually able to suggest an improvement. However, they did not always appreciate why the mistake that had been identified affected the titration result. Answers were, more often than not, well-structured and articulated.

02.4 Students did not always calculate the titres to 2 decimal places and were not always aware that only concordant titres should be used when calculating the mean titre.

02.5 This was well answered, although some students calculated the % uncertainty in their mean titre.

Question 3: Shapes of molecules

A good number of students (26.4%) scored all the marks on this question. However, many added extra lone pairs to the structure of AsF_5 and/or missed including the necessary number of lone pairs on the structure of KrF_2. Students would benefit from being able to draw structures accurately using appropriate wedges to show the 3D nature of molecules and ions.

Question 4: Intermolecular forces

04.1 Students found this one of the more challenging questions. It was common for students to miss off partial charges and/or lone pairs from their diagrams. The hydrogen bond should be drawn from the lone pair to the δ+ H atom and this was not always shown very well. In a few cases students did not show the hydrogen bond between an ammonia molecule and an ethanol molecule.

04.2 This definition was well known, although some students referred incorrectly to the attraction for a lone pair rather than the bonding pair of electrons.

04.3 This was well understood and the majority of students correctly selected H and O as the atoms that would form the most polar bond.

04.4 A good number of students understood that symmetry was an important consideration in this question. However, very few students appreciated that it was the dipoles that cancel and often referred to the polar bonds cancelling each other out.

04.5 Students found this one of the more challenging questions and often did not appreciate that there are no dipole-dipole forces between molecules of CBr_4. In addition, some answers incorrectly considered the idea of breaking covalent bonds rather than overcoming the intermolecular forces.

Question 5: Time of Flight (TOF) Mass Spectrometry

This was generally done well by students, although they 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. A common error was not converting the mass in grams to the mass in kilograms. There were a number of incorrect rearrangements of the expression involving kinetic energy and students appeared to be less comfortable when working on values in standard form.

Question 6: Iodide ions

06.1 This definition was not always answered in terms of electrons but instead in terms of gain of oxygen.

06.2 Equations were not always balanced for atoms or charge. Students found the reduction half-equation more challenging, with less than 15% of students scoring both marks.

06.3 A high number of students were able to identify correctly the foul-smelling gas but only a few students provided an equation to produce S. Many equations showed the formation of sulfur dioxide instead.

Question 7: Equilibria

07.1 Some students attempted to answer this question by considering how the yield changed with pressure (rather than temperature), whilst others did not refer to Le Chatelier's principle alongside the evidence from Figure 1 to support their answer.

07.2 Likewise on this question, some students attempted to answer this question by considering how the yield changed with temperature (rather than pressure). Again, students did not always refer to Le Chatelier's principle alongside the evidence to support their explanation.

07.3 This was not well answered with only about one quarter scoring the mark. Many students just stated that the catalyst would increase the rate, or that it would not affect the position of equilibrium.

07.4 A good number of students were able to calculate correctly the amount, in moles, of ammonia present in the equilibrium mixture. However, some students only calculated the equilibrium concentration of ammonia. There were some errors in the rearrangement of the expression involving K_c to calculate this concentration of ammonia.

07.5 Students did not need to use the values from their calculations of moles in question 07.4. They did not often appreciate that this is the reverse reaction so the value of K_c would be the inverse of that given in question 07.4

Question 8: Test-tube reactions

08.1 Many students did not correctly identify the gas produced as carbon dioxide. Students who did needed to give the correct result of the test using limewater in order to score both the marks on this question.

08.2 Students did not always link the observations from Test 1 and Test 2 to the ions that would be present in hydrochloric acid to justify their answers.

08.3 This was found by students to be a challenging question – very few students were correctly able to describe the test for ammonium ions, whereas the test for sulfate ions was well known.

08.4 Few students appreciated that any silver chloride formed during step 1 would dissolve in dilute ammonia during step 3 so the mass of precipitate would decrease. Some students understood the trend in solubility of the silver halides but did not apply this to the context of the stated method.

SECTION B

Question 09: Atomic Structure
The majority of students (67%) were able to deduce the correct atom, although some did not recall that protons also contribute to the atomic mass.

Question 10: Unpaired electrons
About half the students were able to identify the atom with two unpaired electrons.

Question 11: Successive ionisation energies
Most students (70%) were correctly able to identify an element from a list of successive ionisation energies

Question 12: Comparing ionisation energies
About half the students were able to compare the relative size of first ionisation energies based on electron configurations.

Question 13: Isotopes
This question was well answered, with most students (90%) understanding the concept of isotopes.

Question 14: Empirical formula
The majority of students (65%) were correctly able to determine an empirical formula.

Question 15: Co-ordinate bonding
A high number of students (80%) were able to identify the formation of a co-ordinate bond in a reaction.

Question 16: Group 7
Many students (62%) were able to identify correctly trends down group 7.

Question 17: Ionic radius
About half the students were able to identify the ion with the largest ionic radius. A particularly common incorrect answer was that with the smallest ionic radius.

Question 18: Halide ion reactions
Less than a third of students were able to identify the correct reaction involving halide ions.

Question 19: Oxidation state
About half the students could identify when oxygen was in its highest oxidation state.

Question 20: Blocks
Most students (85%) were able to identify samarium as an f block element.

Question 21: Chlorine
Only about a third of students were able to identify the products of the reactions between chlorine and water.

Question 22: Magnesium
About half the students understood that magnesium oxide is a product when magnesium reacts with steam.

Question 23: Conductivity
Some students (43%) were able to consider correctly the particles in different substances that are responsible for conducting electricity.

Mark Ranges and Award of Grades

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