AQA

A-LEVEL
CHEMISTRY

7405/1 Inorganic and Physical Chemistry
Report on the Examination

7405
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General Comments

The paper differentiated well between students of differing ability. There was no evidence to suggest that students were short of time to complete the paper. All question parts were answered correctly by some students. The best students showed a real depth of understanding of the concepts studied at A-level. Some students failed to gain marks for equations because they failed to check that they were balanced in terms of the number of atoms and/or the charges, especially the charges on complex ions. Some handwriting was difficult to read, introducing the possibility of ambiguity, especially with state symbols in equations. Students must once again be reminded to cross out work that is not to be marked. Often, work not crossed out on the script was contradicted by work on additional pages; this caused otherwise credit-worthy responses to be discounted. Students experienced most problems with the questions on structure and bonding, electrode potentials and aqueous chemistry.

Question 1 Lattice Enthalpies

01.1 Over 50% of students answered this part correctly, but some failed to gain maximum marks by omitting state symbols or electrons in the equations.

01.2 This was answered less well with many students failing to divide the bond dissociation energy for oxygen by two. Some calculated the enthalpy of lattice dissociation rather than formation. Just over a third of students scored zero here.

Question 2 Equilibria

02.1 Most students calculated the partial pressure of ammonia correctly but could not calculate the partial pressures of the other two gases; the idea that the total pressure is the sum of the partial pressures was missed by many students.

02.2 Students answered this part well and most (70.8%) gave the correct expression; common errors included using square brackets, that denote concentration, or inverting the expression.

02.3 Most students were able to calculate the equilibrium constant, but often the units were given as $mol^2\,dm^{-6}$.

02.4 Most students could state that the value of K_p would decrease because the reaction was exothermic but failed to link this to Le Chatelier's principle and did not state that the equilibrium shifts/moves to oppose the increase in temperature.

Question 3 Entropy and Gibbs Free-energy

03.1 Nearly all students (91.1%) gained both marks here.

03.2 Although 73.9% of students scored two marks, common errors here included a failure to convert temperature into kelvin or using inconsistent energy units.

03.3 Students found the explanation in part 03.3 more challenging and many could not state that the Gibbs free-energy would become more negative. Many students, however, scored the second mark for a correct reference to a change in entropy.

03.4 Many students discussed the general principles of homogeneous catalysis or the lowering of activation energy rather than the reaction on the platinum surface. The mark most commonly missed was the idea that the product desorbed from or left the surface of the catalyst. Surprisingly, over 10% of students made no attempt at this question.

03.5 74.4% of students answered this correctly, although a few students thought the oxidation state of N in ammonia was +3.

03.6 Many students gave hydrogen as the other product or failed to balance an equation in which water was the other product.

Question 4 s-block Metals

04.1 The electron configuration was well known (88.9% correct).

04.2 Only the best students gained both marks here (19%); many students focused on whether the electron was being removed from a full or partially full orbital instead of considering why the attraction between the nucleus and the electron might be different.

04.3 Less than half of the students (39.5%) could give the correct answer here; lithium was a common error.

04.4 The majority of students (76.3%) answered this correctly, although there were quite a number who gave the incorrect formula.

04.5 The ionic equation was generally correct and many students could also calculate that barium chloride was in excess. Just under a third of students managed to score all three marks.

04.6 Most students could state why isotopes have the same chemical properties. In the calculation, many students gave an algebraic equation with two unknowns and could not proceed any further. The students who gave a correct algebraic expression with one unknown could work through the calculation and generally gained full marks. Some students answered the question by trial and error and this was also given full credit. Pleasingly, 43.7% of students gained all four marks available.

04.7 Most students deduced that the mass number of the ion would be 138 but less than 30% of students could give the correct formula for the ion including its charge.

04.8 Some students answered this part very well (with 36.6% scoring full marks), but most students scored partial marks or no marks; common errors included failure to use the Avogadro constant, not converting mass to kg, and incorrect rearrangement of expressions.

Question 5 Strong and Weak Acids

05.1 86.2% of students gave the correct definition.

05.2 Most students calculated the amounts, in moles, of the reactants but often did not multiply the amount of barium hydroxide by two to give the amount of hydroxide ions. Some students did not convert the amount in moles to concentration and some did not quote their pH to two decimal places. This part of the question discriminated very well, with just over 20% of students scoring full marks.

05.3 81.8% of students gave the correct reason here.

05.4 78.5% correctly identified sulphur dioxide.

05.5 91% of students could give the correct expression for K_a.

05.6 Most students could calculate the amount, in moles, of hydrochloric acid and of ethanoic acid, but many were unsure of how to use these numbers. Many students failed to recognise the need to increase the amount of acid and decrease the amount of salt due to the shift in the equilibrium when H^+ ions are added. Many added and subtracted the wrong way round or managed one process but not the other. Students could generally rearrange the K_a expression correctly; just over 40% of students scored full marks for this part of the question.

Question 6 Electrochemistry

06.1 Although 73.4% of students were able to answer correctly, some stated that the circuit was completed by the flow of electrons.

06.2 Nearly two-thirds of the students (65.6%) could calculate the EMF of the cell.

06.3 Students knew that the concentrations of copper sulfate were different but only just over 20% of them could state that the left-hand electrode's concentration needed to be 1 mol dm^{-3}.

06.4 Many students did not give state symbols and a few gave extra phase boundaries and platinum electrodes.

06.5 Only the best students (15.5%) scored both marks. Many students could state that the concentration of copper ions would increase but then thought that the reagents would run out.

Question 7 Aqueous Chemistry

07.1 Just over half of the students (50.2%) could give the correct equation; common errors included giving chlorine as a product, incorrect balancing and sometimes an incorrect formula for aluminium chloride.

07.2 Only a small proportion of students (22.6%) could give a correct equation here; many did not include protonation of water, as implied in the question. A surprisingly high proportion of students (10.8%) failed even to attempt this question.

07.3 Here, students were more able to state observations than to write the equations. Some students stated that carbon dioxide was evolved, but this is not an observation – it is a deduction from the effervescence seen. Just over 25% of students scored all the marks in this part of the question.

07.4 Students were better able to state observations than write equations but only 35% of students scored all of the marks available. Again, just over 10% of students failed to attempt this part.

Question 8 Sodium and its Compounds

08.1 This levels-of-response question discriminated very well, with approximately one third of students scoring marks in each of the three levels. Some excellent answers were seen. Some students, however, answered very well initially but then used wrong terminology, for example wrong bonding and/or intermolecular forces in all/some of the substances, and showed contradictions in their answers.

08.2 Unfortunately, the equation was often seen with sodium oxide as the product rather than sodium hydroxide. In the calculation, many students did not use the 2:1 ratio from the equation, leading to an answer of 267 cm^3. However, this part of the question also discriminated well, with over 25% of students gaining full marks; most students scored some marks and less than 3% scored zero.

08.3 Just under half of the students (48.5%) gave a correct answer; the commonest error was to multiply the amount, in moles, by volume rather than dividing by volume.

08.4 This part discriminated well, though only a few students (7%) scored full marks. The structure often had the wrong number of lone pairs and/or the wrong bond angle. That lone pair-lone pair repulsion is greater than bond pair-bond pair repulsion was known by the majority of students.

Question 9 Vanadium Compounds and Ions

09.1 Only 11.3% of students scored both marks here; sometimes Fe^{2+} was chosen but students could not explain their choice. The most common incorrect answer was Zn^{2+}.

09.2 Just over three-quarters of students could give the oxidation state.

09.3 The structure was often given, incorrectly, as a mirror image and the type of isomerism as optical; only 37.2% of students scored both marks.

09.4 This was poorly answered, with only just over a third of students giving the correct equation.

09.5 Over half of the students (55.6%) gave the correct equations; incorrect equations included charged vanadium species. Surprisingly, 12% of students were unable to make any attempt at this question.

Question 10

10.1 This challenging question discriminated very well, with 16.6% of students scoring all of the marks and 20% scoring zero marks; 5.7% did not attempt this question. Many students calculated the amount, in moles, of hydrochloric acid added and the amount of sodium hydroxide used in the titration. Many did not then multiply the amount of sodium hydroxide by 10 to calculate the total amount, in moles, of hydrochloric acid remaining and fewer students still were able to calculate the original amount of sodium carbonate. Many students could convert mg to g. Only the best students could continue to the end and calculate that $x = 1$.

Mark Ranges and Award of Grades

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