A LEVEL

Chemistry

7405/1 Inorganic and Physical Chemistry
Report on the Examination

7405

November 2020

Version: 1.0

General Introduction to the November Series

This has been an unusual exam series in many ways. Entry patterns have been very different from those normally seen in the summer, and students had a very different experience in preparation for these exams. It is therefore more difficult to make meaningful comparisons between the range of student responses seen in this series and those seen in a normal summer series. The smaller entry also means that there is less evidence available for examiners to comment on.

In this report, senior examiners will summarise the performance of students in this series in a way that is as helpful as possible to teachers preparing future cohorts while taking into account the unusual circumstances and limited evidence available.

Overview of Entry

The entry for this paper was vastly reduced from a normal summer series, from around 26 000 to just over 1200.

The general standard of responses seen overall was somewhat similar to a normal summer series. The paper produced a wide range of marks from 1 to 100 (out of 105), with a mean mark of 56.2, only very slightly lower than that in summer 2019. Fully correct responses were seen in all parts of all questions.

The paper differentiated well, and students were able to complete the questions in the time available. All questions were correctly answered by a good number of students apart from question 11.4 which was the most difficult question on the paper.

Answers to the questions on inorganic chemistry showed that this branch of chemistry was not well known; equations were often unbalanced and complexes often had mistakes such as misplaced brackets or incorrect charges. Several transcription errors were seen where students had incorrectly copied the values given in calculations. Some handwriting was difficult to read, introducing the possibility of ambiguity, especially with state symbols in equations.

Comments on Individual Questions

Question 1

Many students failed to gain a mark in part 01.1 by failing to divide their final answer by two.

In 01.2, many different answers were seen; some students did correctly match the lattice energies to the correct substance.

Most students gave the correct answer in 01.3.

Question 01.4 was more challenging; many students failed to gain the first mark by referring to atoms rather than ions. Very few students explained that the attraction between the positive ion and a water molecule is due to the δ– charge on the oxygen of the water molecule or to the oxygen's lone pair.

In 01.5, many students gained all the marks but some students could not construct a correct cycle and therefore struggled.

Question 2

02.1 was not well answered; common incorrect answers often omitted reference to the average mass of an atom.

In 02.2, most students deduced that the percentage of the missing isotopes added up to 13.9, but many students were unable to write an expression in terms of one unknown and could make no further progress. Most students who calculated a value of the abundance for one isotope could find the percentage of the other.

Most students answered 02.3 well.

In 02.4, most students stated that there had to be ions for detection but fewer talked about the need for acceleration; some students failed to gain marks through giving incorrect detail, eg acceleration by a magnetic field.

Although many students scored full marks in 02.5, common errors included a failure to calculate the mass of the ion in kg or a failure to use the Avogadro number correctly. The kinetic energy was often transcribed incorrectly.

Question 3

Students were about equally divided over whether the second ionisation energy would be higher or lower than that of aluminium in 03.1.

There were many different answers in 03.2; argon, sulfur and chlorine were common wrong answers. In the equation the state symbols were often difficult to read and therefore ambiguous, so could not score the mark; sometimes the state symbols were missing.

03.3 was generally well answered. The increase in nuclear charge was well known but the similarity in shielding less so.

Answers to 03.4 were well done.

In 03.5, many students gave P_2O_5 instead of P_4O_{10} as the product and some students did not attempt to balance the equation.

Question 4

Most students scored the mark in 04.1.

Answers to 04.2 were well done but some students omitted the square brackets.

Students found 04.3 more challenging. Often the concentration of the diluted acid was incorrect and some students failed to take a square root in their calculation. Most students could convert their concentration of H^+ ions to a pH.

Some students scored full marks in 04.4 but for many the question presented several challenges. Most students correctly calculated the concentration of H^+ ions but then could not rearrange the expression to calculate the concentration of propanoate ions. Some students failed to notice that only 500 cm^3 of the buffer solution was used and a few did not use the correct M_r for sodium propanoate.

Question 5

The formula in 05.1 was correctly given by some students; the observation was well known. The equation was correct in only a small proportion of responses; students often failed to balance the equation and some failed to include water as a product.

In 05.2, many students did not give the correct formula of the complex ion; common incorrect answers included $Al(H_2O)_3(OH)_3$ or complex ions with positive charges. Some students incorrectly gave heat, reflux or concentrated alkali as the condition. Students who had the correct formula for the aluminate complex often did not balance the equation correctly or started from $Al(H_2O)_3(OH)_3$.

05.3 proved challenging for many students. Complex ions were given with a number of EDTA ligands attached to aluminium or a mixture of EDTA ligands and water ligands; the charge was often incorrect even for an otherwise correct complex.

Answers to 05.4 were not well done. Many students tried to give an equation involving a base other than water. Many students failed to explain their answers clearly enough to score marks; common errors included stating that aluminium or the aluminium complex has a high charge to size ratio. The bond that was weakened was not clearly stated and there was a failure to state that H^+ ions are released which makes the solution acidic.

Question 6

In 06.1, students often failed to mark the cross with sufficient accuracy; many students did not put the cross on the correct axis but, instead, on the curve or on the wrong axis.

Many students failed to calculate correctly the amount, in moles, of hydrogen at equilibrium in 06.2. However, most students could take their mole fraction and find the partial pressure correctly.

Most students gave the expression correctly with correct units in 06.3; some students expressed the equilibrium constant in terms of concentrations rather than partial pressures with appropriate units, and failed to score any marks.

In 06.4, many students who gave the correct answer that the partial pressure of methanol increased thought this was because K_p also increased.

Many students knew that K_p was unchanged in 06.5 but then failed to explain the reason fully; common errors included that a catalyst increases the rate of both reactions or lowers the activation energy by providing an alternative route.

Question 7

Most students could work out the number of bonding pairs and lone pairs in the compounds; students who drew structures scored better generally than students who did not. More able students then went on to write correctly about intermolecular forces; most understood that XeF_4 has stronger intermolecular forces because the molecule is bigger. Only the very best students realised that PF_3 has dipole-dipole forces between molecules and these must nevertheless be weaker than the van der Waals intermolecular forces in XeF_4.

Question 8

Many students scored full marks in 08.1 but for some the question proved challenging. Most students calculated the amount in moles of thiosulphate correctly and many then went on to calculate the amount in moles of iodine; some introduced incorrect ratios to determine the amount of chlorate(I). Many students assumed that the volume of the diluted solution was 250 cm^3 and not 100 cm^3, as stated in the question, and multiplied by the wrong factor. Some students used the M_r of ClO^- rather than NaClO and some were unable to use the density to work out the mass of the original sample.

Many students correctly answered 08.2.

Question 9

Most students knew there would be no reaction and therefore no visible observation in 09.1; the most common incorrect answer was a white precipitate.

In 09.2, most students gave a correct observation and the correct equation was often seen; the role of the chloride ion was less well understood.

Students found 09.3 more challenging; only a few students gave a correct equation. The explanation was not well done. Although some students gave the oxidation states correctly, they either failed to identify the oxidation or reduction processes or they gave them the wrong way round; many students thought hydrogen was the element being reduced or oxidised.

In 09.4, many students incorrectly gave the colour of bromine as a brown solution and some students failed to gain marks by simply stating a colour but omitting to state that a solution formed. Many students were unable to write a correct ionic equation; some students gave an unbalanced ionic equation and some gave a full equation including sodium ions.

Question 10

In 10.1, many students calculated the enthalpy change incorrectly as +49 kJ mol^{-1}. There were several different answers calculated for the entropy change and a few students omitted the conversion into kJ. Most students knew the equation for the Gibbs free energy change and were thus able to calculate a value for the Gibbs free energy change with their values.

Students found 10.2 challenging. Some students realised that the *y*-intercept was equal to the ΔH of the reaction and knew that the gradient was $-\Delta S$; these students read the axes carefully and calculated values for the thermodynamic quantities. A few students interchanged the values for ΔH and ΔS.
Most students knew that a negative ΔG meant that a reaction would be feasible in 10.3. Students often failed to gain the mark by giving a temperature of 840 K or below or, less commonly, above 860 K.

Question 11

Most students found this question challenging. Most students were unable to give a correct equation in 11.1 and 11.2; some students wrote the correct substance on the correct side of the equation but then added electrons to the wrong side.

In 11.3, most students gave an unbalanced equation; some students reversed the equation and gave the equation for photosynthesis and some students failed to cancel out water molecules on each side of the equation.

11.4 was the most challenging question on the paper. Very few students suggested the correct substance for the electrode and students seldom gave the reduced and oxidised species in the correct order.

Some students gave a correct answer in 11.5. Incorrect answers included use of a salt bridge, use of standard conditions, replacing electrodes and adding more oxygen or water.

Mark Ranges and Award of Grades

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