# A-LEVEL
# CHEMISTRY

7405/1: Paper 1: Inorganic and Physical Chemistry
Report on the Examination

7405
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## General Comments

The paper was able to differentiate between students of differing ability. The more able students were able to demonstrate their understanding of all the concepts studied at A-level. All questions were answered fully correctly by at least some of the students. There was no evidence to suggest that students were short of time to complete the paper.

Often students failed to check that equations were balanced in terms of the number of atoms and/or the charges. Some handwriting was difficult to read and this introduced ambiguity, eg with state symbols in equations. Students should be reminded to cross out work that is not to be marked, so that examiners do not see two attempts at a question which contradict each other; this prevents marks from being gained. Students had most problems with questions on time of flight mass spectrometry, shapes of molecules and practical techniques. Aqueous chemistry was not well known; the formula of a complex often had mistakes such as misplaced brackets or incorrect charges, and equations were often unbalanced.

## Question 1

1.1 Most students were able to complete the Born−Haber cycle; the most common error was the omission of the electron on the top line.

1.2 Students found part 2 more difficult; many were able to allocate the correct values to the correct steps in the cycle, but incorrectly reversed the signs of some of the values. Some students either doubled or halved the electron affinity of iodine, and others multiplied the correct answer by 2 or halved it.

1.3 Here, many students did not realise that the difference between the experimental value and the theoretical value was minimal, and therefore the bonding is very close to purely ionic.

1.4 Many students completed this calculation successfully; common errors included failing to halve the entropy value for iodine, omitting the conversion of temperature to Kelvin, or the conversion of $\Delta S$ into kJ $mol^{-1}$. Some students elicited a correct answer but failed to give any units.

## Question 2

2.1 Only the more able students scored all the marks; students were not clear about how electrospray ionisation occurs, and many could not write the equation.

2.2 The most common incorrect answer was 556; students did not realise that the relative molecular mass of P would be 1 unit less than the peak shown in the mass spectrum.

2.3 About half the students scored all the marks in part 3. Common errors included dividing by Avogadro’s number or dividing by 1000; some students could not rearrange the equation to find the mass of an ion, and some had difficulty in calculating the speed of the ion from the distance and time.

## Question 3

3.1 Very few students gave a correct explanation of periodicity; most students described a single trend across a period and a significant number described trends in groups.

3.2 This was answered correctly by most students.

3.3 Those who gave potassium as the element here almost always stated it had the lowest number of protons, but some then failed to mention similar shielding; very few students could not identify the element.

3.4 Amphoteric was well known, although the spelling was often incorrect.

3.5 Only about 25% of students could balance this equation.

**Question 4**

4.1 The formula was well known but the colour of the precipitate less so. The equation was only familiar to a small number of students; the required ratio of 2:3 for the iron(III) ion: carbonate ion was often incorrect.

4.2 The formula was generally well known. Some students used HCl in their equation but then failed to balance with hydrogen ions on the right-hand side.

4.3 Very few students could give a correct reducing agent in part 3; some suggested iodide ions but this is not a reagent.

4.4 Here, the colour of the precipitate was quite well known but the formula less so; many students included ammonia in the complex and did not recognise this as a hydrolysis reaction. Answers such as $[Fe(NH_3)_6]^{2+}$ or $[Fe(NH_3)_4(H_2O)_2]^{2+}$ were common.

4.5 Students often scored well on this levels of response question. Shapes of complexes were well known and most students scored the first two marks. Geometric isomerism in square-planar platinum complexes was well known; cis-trans isomerism in octahedral complexes was less well known. Optical isomerism in octahedral complexes with bidentate ligands was less well understood. Students failed to score full marks by giving an incorrect formula of a bidentate ligand, or not drawing both stereoisomers.

**Question 5**

5.1 Most students gave a correct equation in part 1 but the second mark was gained less frequently, with the role being defined incorrectly.

5.2 Students found this part more challenging; a few students gave a correct equation starting from sodium bromide, but equations starting from bromide ions were more successful. The observation was not well known; many students gave red fumes or brown liquid/brown solution. Mark 3 was scored more often; very few students could not state the role of sulfuric acid.

5.3 This was answered correctly by over 75% of students.

5.4 Most students knew chlorine was both oxidised and reduced or that this was an example of disproportionation; some students failed to gain the mark by stating either that the chlorine was reduced or that the chlorine was oxidised, but not both.

5.5 Only the most able students scored highly here. The formula of D was quite well known; E was often incorrect and those who knew it was silver carbonate often gave the wrong formula. The identity of F as $CO_2$ was often the only mark scored. The first equation often showed precipitation of AgBr rather than $Ag_2CO_3$. The formula of the diaminosilver(I) complex was not well known and those who did know it often could not give a balanced equation.

**Question 6**

6.1 More able students, who were able to transfer mole ratios between the two equations, generally performed well and gained full marks. The most common error was a lack of understanding of the stoichiometric ratio, with many students incorrectly assuming that the amount in moles of $Cu^{2+}$ was either half or double the amount of $S_2O_3^{2-}$; other errors included failing to scale up the amount in moles by a factor of 10 to account for the volume change and converting from mg to g incorrectly by dividing by 100 rather than 1000. Most students quoted their answer to 3 significant figures.

6.2 Many students failed to score in part 2, with responses suggesting changes to apparatus. Some students stated that the volume of thiosulphate should be larger without explaining how this was to be achieved, and some suggested that the concentration of the solution should be smaller but did not specify which concentration should be changed.

6.3 This was well answered, though common errors included base, catalyst and reducing agent.

6.4 Part 4 was answered correctly by nearly 60% of students; the most common error was to lose the 3d electrons instead of the 4s electrons.

6.5 Students found this part challenging; most students did not recognise that the 3d sub-shell is full and therefore were unable to explain that d-d transitions are not possible and visible light is not absorbed.

6.6 Just over one-third of students scored all the marks. Most students used the ideal gas equation correctly but many used the $A_r$ of iodine atoms (126.9) rather than the $M_r$ of $I_2$ (253.8). Another common error was in the conversion of $m^3$ to $cm^3$ by using a conversion factor of $1 \times 10^3$ rather than $1 \times 10^6$.

**Question 7**

7.1 Many students failed to use the 2:1 ratio for sulfur dioxide:oxygen; some then failed to multiply by the $M_r$ of oxygen and used the $A_r$ of oxygen instead.

7.2 Most students gained the mole fractions mark in part 2. Several students did not gain the second mark by failing to give the symbol for the partial pressures or by using square brackets. Many students could not rearrange the equation or failed to square the relevant partial pressures in their calculation.

7.3 Students generally answered part 3 well.

7.4 Very few students could calculate the value of $K_p$, but the mark for the units was awarded more often.

**Question 8**

8.1 Answers to part 1 were poor. Many students omitted all the lone pairs on the oxygen atoms or the necessary partial charges; only the more able students appreciated the linear nature of hydrogen bonds.

8.2 This was well answered; students were aware of the different intermolecular forces in the two molecules.

8.3 Only the most able students scored all the marks. Many students failed to show the double bond in $POCl_3$ and many of the $ClF_4^-$ ions were missing one or both lone pairs; the names of the shapes and the bond angle were often incorrect.

**Question 9**

9.1 Part 1 was answered well; students were familiar with the relationship between pH and $[H^+]$.

9.2 Answers to this part were poor. Very few students suggested finding the pH at half-equivalence and from those who did, there was a tendency to quote a value for pH from the full equivalence part of the graph. Some students had more success by using the initial pH and following the weak acid approximation route to find $K_a$.

9.3 Most students could identify the most appropriate indicator.

9.4 Most students were awarded the two marks for a $K_a$ expression and calculating the amount in moles of HX. A significant number of students subtracted the amount of anion present at the start from the amount, in moles, of acid but only some attempted to change the amount of weak acid and/or anion after the addition of KOH. Those students who had the correct values after the addition of KOH, could generally re-arrange the expression for $K_a$ to gain a pH value and almost invariably gave this to 2 d.p.

9.5 Only a very small number of students could give a correct mathematical expression.

**Mark Ranges and Award of Grades**

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