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

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General Comments

This fourth examination of the new specification highlighted some key points for teachers going forwards.

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
- show working out clearly with a clear explanation for each step of their calculation, particularly in unstructured and extended calculations
- understand how to convert numerical values to take into account different units
- understand different types of ionisation that occur in time of flight mass spectrometry.

Section A

Question 1: Compounds that Contain Fluorine

01.1 Many students understood that the key reason for the difference in size of the two isoelectronic ions was the difference in the number of protons. However, many students made reference to differences in atomic radius rather than ionic radius. Students did not always answer with an explanation of the difference in the attraction.

01.2 A good number of students realised that the reason for the high melting point was the attraction between oppositely charged ions, but some students did not appreciate that sodium fluoride was ionic. Equally, students did not always appreciate that because the melting point is high, it shows that lots of energy is needed to melt the compound.

01.3 A high number of students did not appreciate that the type of bond formed was a co-ordinate bond. Instead, many described this as a hydrogen bond due to the interaction between a fluorine atom and a hydrogen atom. However, students who recognised this as a coordinate bond were able correctly to explain how this bond is formed.

01.4 A good number of students were able to draw and name both shapes correctly, although many did not appreciate that there are two lone pairs on the H_2F^+ ion. Some students showed additional lone pairs and did not show the H_2F^+ ion as bent but drew the ion as linear.

01.5 Many students coped well with this calculation and realised that there were two C–F bonds. However, a good number of students missed the C–C bond in the product. Calculations were not always well set out, with some students giving a string of numbers. It would be helpful for students to set out their calculations with a clear explanation of what each of their intermediate values represents.

Question 2: Time of Flight Mass Spectrometry

02.1 Students were not always able to describe the process for electrospray ionisation, with a large number describing the process for electron impact ionisation. Both ionisation methods are described in the student guide on the subject pages of the website.

02.2 Few students gave the formula of an ion in response to this question, although many appreciated that the lightest particle would reach the detector first.

02.3 This question was answered well by students, with the majority scoring the mark, although there were a good number of cases where students did not include state symbols or gave incorrect state symbols.

02.4 This question proved challenging for students. The velocity was frequently calculated well, although a number of students did not convert the length of the flight tube into metres. Similarly, students were not always able to rearrange the expression for kinetic energy correctly to make mass the subject. Many students realised the need to convert the mass into grams by multiplying by 1000, but a good number were not able to use Avogadro's constant correctly to determine the mass of one mole of ions; it appeared that the mass of a mole was not well understood by students. Most students who reached the end of the calculation realised that the mass number should be a whole number.

Question 3: Chromium and its Compounds

03.1 Many students were able to write the electron configuration of a chromium atom correctly, although a good number did not appreciate that a chromium atom only has one 4s electron.

03.2 Students generally answered this question well, although a good number gave the relative atomic mass rather than the mass number of the atom.

03.3 This question was well answered, with many students able to show that the mass number of the fourth isotope was 50, although working out was not always clear.

03.4 This question was also well answered, with the majority of students giving correct answers. Some students did not take the overall charge into account when determining the oxidation state of the chromium in this ion, however.

03.5 – 03.7 Students were generally able to write a half-equation for the oxidation of iodide ions to iodine, whilst writing a half-equation for the reduction of $Cr_2O_7^{2-}$ ions to Cr^{3+} ions proved to be more challenging, with many students forgetting to balance the chromium atoms. Students who succeeded in writing the first two half-equations were usually able to combine them in 03.7 to give a correctly balanced full equation for the reaction.

Question 4: Ionisation Energies

On this question a good number of students were able to explain the trend across the period in detail, giving explanations for the general trend as well as the two deviations in the trend. However, some students confused period 2 with Period 3 and referred to elements from period 3, or to 3s/3p sub-shells in their explanations. Equally, some students only explained the general trend across the period without reference to the deviations that occur between beryllium and boron and also between nitrogen and oxygen.

Question 5: The Equilibrium Constant, K_c

05.1 A good number of students were able to calculate correctly the moles of NO, and of Cl_2 in the equilibrium mixture. However, students often also assumed that the equilibrium moles of NOCl was the same as the equilibrium moles of NO.

05.2 The expression for the equilibrium constant was well done by over two-thirds of students, although a few had the expression upside down. Similarly, a number of students had added the concentrations of NO and Cl_2 rather than multiplying them.

05.3 This question proved to be challenging, with a number of students not converting the equilibrium moles to concentration for use in their expression for K_c. Similarly, students did not convert their final calculated concentration of NOCl into moles by multiplying by the volume. Some students struggled to rearrange the expression for K_c correctly.

Question 6: The Relative Formula Mass of an Unknown Acid

06.1 A pleasing number of students scored well on this question, with almost all students making some progress through the calculation. Many students correctly calculated the mean titre, although there were a good number of students who used all three values to calculate the mean without discarding the non-concordant results. Students generally appreciated that this was not a 1:1 reaction, but a good number mixed up the two volumes and so calculated an incorrect number of moles of sodium hydroxide, and used the wrong scaling factor.

06.2 Students generally fared well on this question, although some used their average titre value rather than the pipette volume for their calculation. Some students had doubled the uncertainty in their calculations. Examples of where this doubling would be appropriate can be found in the practical handbook. A surprising number of students did not attempt this question, suggesting they were unfamiliar with this practical context.

06.3 and 06.4 Students found these questions on practical techniques challenging. Students need to appreciate the *reasons* for aspects of practical procedures in the required practical activities. In 06.3, the idea that acid solution will have filled the jet space but had not been released into the conical flask was not well understood, whilst in 06.4 students often made references to there being no change in concentration of the solutions in the flask. This showed the importance of students understanding why they are doing what they are doing in a practical procedure rather than just following instructions.

Question 7: Magnesium and its Compounds

07.1 The equation for the use of magnesium in the extraction of titanium was not well known by students, although many understood its role as a reducing agent.

07.2 This question proved challenging for many students, with a high proportion (over 10%) not even attempting the calculation. Many students did not appreciate that the water collected was only formed from the reaction of the hydroxide with carbon dioxide, and many had assumed that the moles of water was the same as the moles of the oxide.

Question 8: Distinguishing Between Pairs of Compounds

08.1 The question was found to be quite challenging, with a high number of students choosing silver nitrate to distinguish between these two compounds. However, a good number of students were able to select a compound containing sulphate ions and then describe correct observations.

08.2 This question also proved to be challenging. Although many students chose to distinguish between these two compounds using an acid, some students chose to use acidified silver nitrate. These students did not always appreciate that the sodium carbonate solution would react with the acidified silver nitrate as well as the sodium chloride solution.

Section B

Question 9: Number of particles

Just over a third of students were able to deduce which sample contained the greatest number of particles. However, many did not appreciate that there were more hydrogen molecules in 1 g than there are in 1 dm^3 (measured at room temperature and pressure).

Question 10: Empirical Formula

Just over half of students were correctly able to deduce the empirical formula of the oxide.

Question 11: Bonding and structure

The vast majority of students were able to identify the substance that had delocalised electrons.

Question 12: Shapes of molecules and ions

More than half of the students could identify the species that was not pyramidal.

Question 13: Vaporisation of water

Around three-quarters of students understood the changes that occurred when a sample of water is vaporised.

Question 14: Standard enthalpy of formation

Nearly 60% of students were able to select the equation that correctly represented the standard enthalpy of formation of barium chloride.

Question 15: Redox reactions

Just under half of students were able to select the equation that did not represent a redox reaction.

Question 16: Properties of group 2 elements

Half of the students were able to choose the correct property of the element radium.

Question 17: Properties of group 2 elements

The majority of students understood that strontium reacted more vigorously with water than calcium. However, a good number also thought that calcium hydroxide was more soluble in water than strontium hydroxide.

Question 18: Properties of group 2 elements

Over 70% of students were able to select the property that increases down group 2.

Question 19: Oxidising Ability

A good number of students were able to select the best oxidising agent. However a large number of students confused the oxidising ability of the halogens with the reducing ability of halide ions.

Question 20: Calorimetry

A good number of students were able to show the amount of energy absorbed by water in a calorimetry experiment. However, almost as many students thought that 273 should be added to the temperature change for this calculation.

Question 21: Combustion

Only just over one-third of students were able to select the correct statement about the volume of gas in this reaction. Other answers were approximately equally likely to be chosen.

Question 22: Reactions involving halide ions

Just over half of students were able to decide on the correct statement about reactions involving halide ions in terms of their reducing ability.

Question 23: Percentage yield

The most common answer (B) was incorrect as students did not appreciate that 50g of aluminium oxide do not product 50g of aluminium.

Mark Ranges and Award of Grades

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