



AS

CHEMISTRY

7404/1 Inorganic and Physical Chemistry

Report on the examination

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The Report on the Examination

This examination of the AS specification highlighted some key points about students' performance that may prove useful.

Students need to:

- 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.
- Be able to give answers to calculations to appropriate precision based on the precision of the data in the question.
- Make sure that they refer to the stoichiometry in reactions when completing extended mole calculations.
- 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.
- Be able to write ionic equations.
- Be able to combine half-equations to deduce overall equations for redox reactions.

Question 1: The extraction of titanium

- 1.1 The majority of students performed well on this question and were able to calculate the percentage atom economy in the reaction to form titanium(IV) chloride. Students who struggled with this calculation either did not use A_r values when calculating M_r s or did not use the stoichiometric coefficients.
- 1.2 Students did not explore the economic advantages of using a process with a high atom economy and instead gave answers focussed on yield.
- 1.3 The majority of students were able to give a correct chemical equation for the reaction between titanium (IV) chloride and magnesium. However, the role of magnesium was often incorrectly stated as an oxidising agent rather than a reducing agent.
- 1.4 Students found this question very challenging. Whilst students appreciated that magnesium is a reactive metal, they struggled to then suggest why this made the magnesium expensive.

Question 2: Halogens and their compounds

- 2.1 Students usually understood that the reason for increasing boiling points down the group was linked to the larger molecules. However, few students were able to be precise about the nature of the van der Waals' forces (or induced dipole-dipole forces) between the molecules.

- 2.2 Most students were able to give the reason for adding chlorine to water in order to kill bacteria but few students were able to explain clearly why this was safe to do in terms of the toxic chlorine being of low concentration.
- 2.3 The majority of students did not realise that when chlorine reacts with water in sunlight, this leads to the formation of oxygen and instead gave an equation to form hydrochloric acid and chloric(I) acid. Equations that lead to the formation of oxygen were often not correctly balanced.
- 2.4 Students often gave equations that produced hydrochloric acid rather than appreciating that sodium chloride would also be formed in this reaction in addition to sodium chlorate(I).
- 2.5 Most students were able to balanced the equation correctly but fewer were able to deduce the oxidation state of chlorine in NaClO_3
- 2.6 Over half of the students were able to deduce a correct half-equation but a large number of students did not include electrons in their half-equation or gave an incorrect number of electrons.
- 2.7 A large proportion of students were able to identify the halide ion that is able to reduce concentrated sulfuric acid to hydrogen sulphide. Only about one quarter of students were then able to give a correct equation for the reaction of this halide ion with sulfuric acid to form hydrogen sulphide.
- 2.8 About three-quarters of students correctly identified a sodium halide that reacts with concentrated sulfuric acid without any redox taking place. However, less than half were then able to give an equation for the acid-base reaction that takes place whilst some gave equations for a redox reaction rather than an acid-base reaction.

Question 3: Atomic structure and time of flight mass spectrometry

- 3.1 This question was well answered with students correctly giving the full electron configuration of a fluoride ion.
- 3.2 This question was well answered with students correctly identifying Q. However, some students suggested other elements such as Sc or V or Co as the identity rather than Mn
- 3.3 Students were able to give the meaning of the term relative atomic mass although a good number did not state that the scale is relative to the mass of one atom of ^{12}C
- 3.4 This question asked about the principles of a TOF mass spectrometer. Students were not always precise in their language. Students need to state that each ion gains an electron when it is detected and many did not clearly state that the abundance of each ion is proportional the to current.
- 3.5 Students often suggested that the ion that would be last to reach the detector was that with the highest abundance rather than the heaviest ion.
- 3.6 Students were asked to calculate the relative atomic mass of a sample of metal. This was well answered, although some students just averaged the mass numbers rather than calculating the average mass.
- 3.7 Students were asked to calculate the mas of one ion of an isotope using some data from time of flight mass spectrometry. The majority of students made good progress with this more challenging calculation. However, some students did not square their velocity whilst others did not convert the mass generated from using the expression $KE = \frac{1}{2}mv^2$ into grams.

Question 4: Group 2 metals

- 4.1 Students were asked to explain why strontium has a lower melting point than calcium. Many students understood that Sr^{2+} is a larger ion or an ion with a lower charge density. However, a large number of students did not explain that in Strontium there is a weaker attraction for the delocalised electrons and often made reference to the attraction for the outer electrons.
- 4.2 This question was well answered with students giving a reason for increasing atomic radius down Group 2
- 4.3 Students did not often include state symbols in their equation. Students also gave equations that formed BaO rather than Ba(OH)_2
- 4.4 A good number of students were able to give an equation for the process that occurs when the second ionisation energy of calcium is measured. However, many students did not include correct state symbols.
- 4.5 The vast majority of students were correctly able to identify the Group 2 metal with the lowest ionisation energy.

Question 5: Experiment to determine the relative formula mass of H_2A

- 5.1 This calculation was well completed by students with most of them calculating correctly the relative formula mass of the acid. Students should take care to lay out their calculations in a stepwise manner with a clear statement of what each line of working represents. Students often present extended calculations as a jumbled set of numbers that do not always clearly follow on from each other. In this question, students did not always calculate the mean titre correctly and should only use concordant results. In addition, students did not always appreciate that a 25.0 cm^3 sample of the acid solution was used in the titration.
- 5.2 Students found this challenging and often doubled the total uncertainty value when calculating the percentage uncertainty in titration 1.
- 5.3 Students found this question challenging and did not always appreciate that to reduce the percentage uncertainty in a titration they would need to suggest a change that would lead to a higher titre value.

Question 6: Inorganic ion tests

- 6.1 Students found interpreting the observations for a series of test-tube reaction challenging. Correct ionic equations for the reactions. Ionic equations were frequently missing from student answers so only about a quarter of students scored highly on this question. Students did also not always clearly explain how the observations from the Table could be used to identify the ions / compounds present in each solution.
- 6.2 Only about a third of students were able to describe correctly a test to confirm that a solution contains hydroxide ions.

Question 7: Chemical equilibria

- 7.1 Students were asked to show graphically how the concentration of the product of the reaction between hydrogen and iodide changes with time. Students found this question challenging with students not appreciating that the change in the concentration of hydrogen iodide would be twice that of the change in the concentration of iodine.
- 7.2 Students were asked to state and explain the effect of increasing temperature on the equilibrium yield of hydrogen iodide. Students did not always answer in terms of Le Chatelier's Principle. Students need to make sure that they make reference to a shift in the position of equilibrium rather than just suggesting that the equilibrium favours the reactants or products.
- 7.3 Students were asked to calculate a value for the equilibrium constant for the reaction between carbon dioxide with hydrogen to form methanol and water. Students found this challenging. Many students struggled to correctly calculate the amount of hydrogen present in the equilibrium mixture. In addition, students did not always convert the equilibrium quantities to concentration before using these to calculate the value of the equilibrium constant.

Question 8: Formula

This was answered correctly by a majority of students.

Question 9: Ideal gas equation

This was answered correctly by a majority of students.

Question 10: Percentage by mass

The correct answer was the most common answer, although many students had used an incorrect formula of sodium sulphate (VI) in their calculation.

Question 11: Relative sizes of ions

Under half of the students could identify the relative sizes and arrangements of the sizes of the ions in sodium chloride. A large number of students thought that the sodium ion was larger than the chloride ion.

Question 12: History of the atom

This was answered correctly by a majority of students.

Question 13: Limiting reactants

About half of the students were able to correctly calculate the maximum mass of sodium chloride formed from 10.0g of sodium and 10.0g of chlorine.

Question 14: Successive ionisation energies

This was answered correctly by about three-quarters of students.

Question 15: Chemical Equilibrium

A majority of students were able to identify the equilibrium that has a lower yield of product when the pressure is increased at a constant temperature.

Question 16: Electron arrangement

About half the students were able to identify correctly the element that has atoms that contain only two unpaired electrons.

Question 17: Silver halides

About two-thirds of students could identify the silver halide that reacts with concentrated ammonia to form a colourless solution.

Question 18: Enthalpy changes

Students found this challenging with only about one third of students able to consider which combination of solutions would give the greatest temperature change. The most common answer was one where the students considered the maximum number of moles rather than considering that a lower total volume would also lead to a higher temperature rise.

Question 19: Polar molecules

Just under half of students were able to identify which molecule is polar. Many students decided that BF_3 was polar but didn't appreciate that the dipoles in this molecule would cancel out.

Question 20: Redox

Just over half of the students were able to link the idea of the loss of electrons by with changes in oxidation state when SO_2 acts as a reducing agent.

Question 21: Diluting solutions

Students found this challenging and many gave the total volume of the solution rather than calculating the volume of water that needs to be added to a solution to dilute it to give a solution with concentration of $0.0400 \text{ mol dm}^{-3}$

Question 22: Ideal gases

Students found this challenging with only about a quarter of students being able to identify which sample contained the same number of atoms as in 0.287 g of nitrogen at 25.0 cm^3

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results Statistics](#) page of the AQA Website.