



A Level Chemistry

7405/1

Report on the examination

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General

The paper discriminated well. The majority of students were able to answer all the questions. The content of 3.1.11: Electrode potentials and electrochemical cells, appears to be a poorly understood topic.

Equations were often unbalanced or included incorrect formulas. Students occasionally lost marks due to poor handwriting. This was very noticeable when writing state symbols in equations; it must be perfectly clear whether a symbol is an s or g.

In a few cases a black pen had not been used, and the writing was too faint to read accurately. Rough working should be crossed out so that the examiners attention can be drawn to the student's final thoughts; this way there is less risk of an examiner seeing a contradiction that was perhaps not intended.

Students should not round their working too early in any calculation, e.g. if they need an answer to 3 significant figures, they should ideally give intermediate answers to 4 significant figures (or leave the numbers in their calculator for use in the next step).

Question 1

Over half the students scored both marks in part 1; some students were unfamiliar with the correct formula of titanium (IV) chloride and were unable to write a balanced equation. Some students did not know the role of magnesium. Answers to part 2 were good; common errors included incorrect formulas. In part 3 many students knew that magnesium hydroxide was less soluble than sodium hydroxide; common errors included reference to the base strength without linking their ideas to solubility or comparing the reactivity of NaOH and Mg(OH)_2 .

Fewer than half the students scored both marks in part 4; some students did not attempt an ionic equation and used NaOH as their reagent. The bromide was well known in part 5, but many students did not write an ionic equation or omitted the state symbols in their equation. The most common answer for the explanation of acidification was to remove carbonate ions. Occasionally, students answered in terms of false positive results but failed to mention the ions involved. Part 6 was well answered.

Question 2

About 50% of the students gained both marks in part 1; some students lost the second mark for not giving a comparative response or by not referring to the attraction between the nucleus and the outermost electron. Part 2 was well answered by the majority of students. In part 3, about one third of students correctly identified magnesium; argon, aluminium or silicon were common incorrect answers.

Phosphorus was regularly identified in part 4 and most students recognised the jump in ionisation energy from 5 $\rightarrow$ 6; many students did not explain that a jump in the ionisation energy meant that an electron was being removed from an inner energy level. About half the

students scored the mark in part 5; common incorrect answers included $\log 3.5 = 0.54$ and 3.16×10^{-4} .

Question 3

Just over 60% of students answered part 1 correctly. In part 2 many students lost this mark by not identifying the electron pair/lone pair was donated from oxygen to copper. Many incorrect observations were seen in part 3. The students who started with CO_3^{2-} usually gave a correct equation; ions with incorrect formula CO_3^- were common. In part 4 most students gave the correct shapes; the most common error was square planar instead of tetrahedral. Some students did not refer to ligand size and instead gave ideas based on electron pair repulsion theory; some referred to chlorine atoms/molecules rather than chloride ions. Some students did not refer to d orbital splitting.

Many students referred to light being absorbed but did not identify the light as visible or white. Many students knew that the colour seen was light that had not been absorbed. Few students were able to write about the energy gap and what was responsible for the change in the energy gap, although some did reference the equation $\Delta E = h\nu$. Fewer than 20% scored both marks in part 5. Many students gave an incorrect observation. Students found the equation challenging; chlorine was often given as a product, some students had 2 mol of ammonia and 4 mol of water instead of the other way round and the copper complex often lacked a charge.

In part 6 many students could not give a balanced equation; H^+ ions were often omitted from the left-hand side and water from the right-hand side. In part 7 most students gave the correct answer; a common error was to average three of the four titres instead of the two that were concordant. The calculation in part 7 proved challenging; most students were able to score the first three marks but then failed to divide by 2 and were not able to make progress. Some students used 25.0 cm^3 for their titre. Students who had calculated an M_r greater than 275 usually divided this by 2 to get an A_r but often did not assign this to a metal with a +1 oxidation state. Students found part 9 challenging; common errors were to have a 4-coordinate copper or to bond the copper to a $\text{C}_2\text{O}_4^{2-}$ ion via 1 coordinate bond. Many students did not specifically draw the coordinate bonds originating from the O atom of the water.

Question 4

About half the students answered part 1 correctly; many students lost the mark by adding extra incorrect information eg 1 mol dm^{-3} or all elements are in their standard states. Some students stated 1 atmosphere instead of 100 kPa. Many students could do the calculation in part 2; common errors included not applying the stoichiometry in the equation to calculate ΔH and ΔS and failing to use the factor of 1000 to calculate ΔS in $\text{kJ K}^{-1}\text{mol}^{-1}$. A few students could not rearrange the equation. Some students gave negative temperatures which are not appropriate in kelvin. In part 3 about 40% of students gained all the marks; many students made an error with the signs in the equation.

The majority of students divided their final value by 8 and gained one mark although there were a few who divided by 4 and did not appreciate that there were two nitrogen to oxygen bonds in NO_2 . Answers to part 4 were generally good. In part 5 over half the students gained both marks. Some students stated that the equilibrium shifted in the endothermic direction without specifying this as being the reverse direction or without explaining that this was to oppose the change put on the system. It is advised to begin a response with a clear statement: eg the forward reaction is exothermic.

Question 5

Many students failed to mention that van der Waals' forces were between molecules in part 1; a few students referred to chloride and bromide ions. Some students confused the boiling point with ionisation energy and wrote about higher nuclear charge in bromine so stronger attraction between the outer electrons and the nucleus. A number of students thought that the covalent bonds break during a change of state and some students compared the reactivity of chlorine and bromine. Part 2 was generally well answered. Many students drew an acceptable diagram in part 3; a common wrong answer had three bonding pairs and one lone pair. The explanation proved more challenging; some students mentioned electron pairs repelling, but few qualified this with the electron pairs repel to be as far apart as possible. Part 4 differentiated well; observations were often incorrect eg white and cream precipitates, and HBr described as a brown gas. A correct equation for the acid-base equation was more successful than the redox equation. The redox equation was often unbalanced or contained incorrect formulas eg NaSO_4 and BrSO_4 . In part 5 very few students gave an equation to form copper(I) iodide.

Question 6

About one fifth of students gave correct equations in part 1; common errors included not balancing the half-equations with the species, or with electrons. In part 2, very few students explained that hydroxide ions were involved at both electrodes. A few students wrote that hydroxide ions were produced at the positive electrode but did not go further. Many students stated that the reactants were supplied continuously or that it was a reversible reaction. Many students could not answer part 3; some students scored a mark by stating that electrons were released at the negative electrode or by the hydrogen but often didn't go on to explain that these flowed through the external circuit/motor to the other electrode. About one third of students gave the correct answer in part 4; common incorrect answers included N_2 and SO_2 . In part 5, very few students linked storing hydrogen as a liquid to occupying less volume or minimising chance of escape. Part 6 was generally well done. In part 7, some students incorrectly stated that the half equations were the same; the correct idea that combining the two different sets of half equations, in both acidic and alkaline conditions, would lead to the same overall equation was not well understood.

Question 7

Part 1 was well answered. In part 2 many students did not state that layers of atoms/ions can slide over each other; some students stated that metals were malleable or ductile or that vanadium was a metal. The equations in part 3 were generally well done; common errors included unbalanced equations with the correct species, or equations that had the wrong oxidation states for the vanadium oxides, many including positive ions e.g. VO^+ . In part 4, the majority of students did not recognize that the reduction of the vanadium species with tin proceeds in two steps and stops at V(III). A correct understanding of how EMF values determine the spontaneity of redox reactions was essential for full marks. Many students who did start and end with the correct vanadium species did not balance the equation. In part 5 many students clearly explained that the high melting point of ionic compounds is due to the strong electrostatic attraction between oppositely charged ions. Some students demonstrated confusion about the nature of the bonding; common errors included describing the bonding as molecular with van der Waals' forces, macromolecular with covalent bonds, or metallic bonding. Few students were able to construct and balance the initial equation in part 6 to show the formation of the hexa-aqua complex; VO , VO_2^+ and H_2SO_4 were all common products.

A common error was the misidentification of SO_4^{2-} as the acidic species, likely due to its association with sulfuric acid. However, in this context, sulfate is simply a spectator ion and does not contribute to acidity. In part 7 many students were confused by the instruction to use the symbol Q and instead attempted to write equations using the molecular formula. Many students used high energy electrons in their equation to knock an electron off the molecule and those who used the full formula did not add an H^+ to the ion they formed or forgot to add the charge. Equations such as $\text{Q} + \text{H}^+ \rightarrow \text{QH}$ and $\text{Q} + \text{H}^+ \rightarrow \text{Q}^+$ were common. Few students gained M2, as many ignored the instruction to use a mass of 51 for vanadium. Instead, they used the relative atomic mass from the Periodic Table, which led to an incorrect calculated value of 601.9 rather than the expected result based on the given mass. More than 60% of students gained both marks in part 8. The students who found the question challenging could not give an expression linking the abundances of the two isotopes; $49x + 51y = 50.97$ and $49x + 51x = 50.97$ were common. Some students did not add the abundances of their ions to give 100 (or 1).

Question 8

Most students gained two marks in part 1; a few students did not give their answer to 2 d.p. or doubled or halved the concentration of nitric acid to get their $[\text{H}^+]$. In part 2 most students could calculate the $[\text{H}^+]$ from the pH. Students who could write the weak acid approximation generally went on to calculate the $[\text{CH}_3\text{CH}_2\text{COOH}]$ correctly. Answers to parts 3 and 4 were generally good. Many students gave confused answers in part 5; those who wrote an equilibrium equation and then used that to explain the changes were more successful. Many students referred to an equilibrium but did not identify the equation, so the answer was unclear. Students who reacted their added hydroxide with the weak acid were often unsure how to proceed. Very few students mentioned the ratio of the ethanoic acid and ethanoate ion concentrations being roughly constant. Part 6 discriminated well; nearly one third of

students gained all the marks. Most students calculated the moles of HA, A⁻, and hydrochloric acid correctly. A few students went on to correctly calculate the moles of HA and A⁻ after the addition of the hydrochloric acid; some students added the moles of acid to both. Many students used their answers to calculate a value for the [H⁺] after addition and a pH of the final buffer solution. Some students lost the final mark by not giving their answer to 2 decimal places.

Mark Ranges and Award of Grades

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