

A-level

Chemistry

CHEM5 Energetics, Redox and Inorganic Chemistry
Report on the Examination

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General

The standard of this paper proved to be easier than the unit 5 paper in June 2014. The mean was about 5 marks higher. The standard deviation also increased a little so that the paper was able to discriminate very effectively between students of differing abilities.

Question 1

Many students failed to score 2 marks in part (a) for the definition of electron affinity. Common mistakes were to refer to energy rather than enthalpy change, to omit one mole of atoms or ions and to refer to chlorine molecules rather than atoms. Part (b) was usually answered well but some state symbols and electrons were common omissions. Good students scored full marks for part (c) but a very common error amongst others was to use the value of 121 kJ mol^{-1} for the atomisation of chlorine instead of doubling that value to allow for 2 mol of chlorine atoms. In part (d)(i) a common omission was a failure to mention that magnesium ions are smaller than those of sodium and a common error was to suggest that the ions would be attracted to O^{2-} ions in water. Answers to part (d)(ii) were usually correct.

Question 2

Answers to part (a) were often incomplete; many students lost a mark because only one bond was broken rather than 1 mol of bonds. Answers to part (b) were usually correct but a fairly common mistake was to omit to halve the $\text{O}=\text{O}$ bond enthalpy or to calculate a value for the formation of 2 mol of water. Answers to part (c)(i) were usually correct but in part (c)(ii) most students did not score because they did not refer to the O-H bond and some inadvisably thought that experimental error was a sufficient answer.

Question 3

The calculations in parts (a)(i) and (a)(ii) were usually correct although errors in part (a) (ii) sometimes occurred due to a failure to recognise the three moles of hydrogen. Parts (b) and (c) were also answered well and it was pleasing to see that most students ensured that the enthalpy and entropy changes were in the same units before calculating the temperature. Part (d) was answered well by many students though many of these scored only 2 out of the three marks available because the units of free energy were omitted. Students should be encouraged to remember to give units for all numerical answers. Part (d)(ii) proved to be very challenging and only the best students were able to express in words why a lowering of the temperature would eventually lead to a negative value for the free-energy change.

Question 4

The quality of answers to inorganic questions of this type continues to be lower than hoped. The problem lies partly with a lack of knowledge and partly with imprecise language. In part (a) many equations were incorrect, showing formation of magnesium hydroxide rather than magnesium oxide. Students should know that precipitates and effervescence are only observed in reactions that take place in solution. In this question, magnesium oxide is formed as a solid the hydrogen gas produced is invisible. In part (b) the equation was usually correct but the flame colour was not well known.

Question 5

In their answers to questions such as part (a (ii) students should be encouraged to read the question carefully before answering. In this case the question asked students to explain the melting point in terms of structure **and** bonding. Questions 5 (a) (iii) and 5 (b) were answered well by most students. In question 5 (c) a correct equation proved to be a challenge and it was surprising to note how often students attempted to balance an acid-base equation by producing hydrogen gas.

Question 6

Most students gave a correct answer to part (a) but some continued to confuse an oxidising agent with a Lewis acid and incorrectly stated that an oxidising agent is an electron pair acceptor. Inaccurate terminology continues to disadvantage students when they are asked to use electrode potential data to explain the action of oxidising and/or reducing agents. For example, in part (b), the iron (II) ion was the weakest oxidising agent in the Table because the E^\ominus value for the Fe^{2+}/Fe electrode is the least positive (or most negative). It is not precise enough to refer to the electrode potential of iron. In a similar way when gold (I) ions are added to water, the water is oxidised because the electrode potential of the Au^+/Au electrode is more positive than that of the $\text{O}_2/\text{H}_2\text{O}$ electrode. It is correct in this context to say that Au^+ ions are a better oxidising agent than O_2 but it is not correct to say that Au^+ ions are a better oxidising agent than water. Parts (c) and (e) (i) were answered well by many students. Many answers to part (e) (ii) stated incorrectly that chloride ions would react with iron (II) ions. In part (f) similar imprecise use of the correct E^\ominus notation led to no marks being awarded for the use of data.

Question 7

In part (a) the observations were usually described accurately. Attempts at the equations were less successful. Again, students should be encouraged to read the question carefully before starting to answer it. Many students attempted to start from an aqueous solution of chromium(III) ions instead of the solid hydroxide. Students were asked to write ionic equations because it was thought that this would make the equations simpler and easier to write. A significant number of students ignored this instruction and were penalised. In part (b) of this question students were asked to write equations for ligand substitution reactions. It was not possible to answer this question correctly unless it was realised that the initial complex ion, in aqueous solution, was a hexaaqua ion with six water ligands. When describing an observation it is important to give the phase to which the colour applies so that the product of reacting an excess of aqueous ammonia with copper(II) sulphate solution is a 'deep blue solution', not just 'deep blue'.

Question 8

Most students gave correct observations in part (a) but their attempts at equations were less successful and often unbalanced. Very few correct answers to part (b)(i) were seen. The most usual response was to suggest, without any explanation, that the colour change was from purple to colourless. Part (b)(ii) produced a whole range of responses. Good students were able to score all 5 marks in impressive style but others lost marks. The most common mistake was an incorrect equation and the use of an incorrect molar ratio for moles of iron(II) to manganate(VII). Many students were also unable to calculate the concentration of iron(II) ions in the original solution from the number of moles of iron(II) ions in the 250 cm^3 flask. A factor of 1000/50 was required but factors such as 1000/250 or 250/25 were common mistakes.

Question 9

This question proved to be difficult and discriminating. In part (a), only the best students could write a correct equation. The catalyst was usually identified correctly but the way in which the manganese(II) and manganese(III) ions were involved and regenerated in the reaction and the way in which contributed to the lowering of the activation energy were not understood by most students. In part (b) some excellent graphs were sketched although weaker students did not show the expected 'S' shaped curve. In the explanation of the shape of the curve, the increase in reaction rate caused by the increase in catalyst concentration was usually correct but fewer students explained correctly why the rate of reaction then decreased.

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