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General Certificate of Education (A-level)
January 2012

Chemistry CHEM5

(Specification 2420)

Unit 5: Energetics, Redox and Inorganic Chemistry

Report on the Examination

General Comments

The standard of this paper proved to be similar in standard to the CHEM5 paper in January 2011. It had a very similar mean mark and standard deviation.

Question 1

Most answers to part (a) were correct and scored all three marks. The most common error was to confuse enthalpy of lattice dissociation with enthalpy of formation. Part (b) was not answered so well. Weak students often confused electron affinity with ionisation. Part (c) was answered well and many correct answers were seen. Answers to part (d) were less good. The most common error was to confuse atomisation enthalpy for oxygen with bond enthalpy and therefore to use a value of 124 kJ mol^{-1} in the calculation instead of 248 kJ mol^{-1}. Another common error was to give a negative value for the answer – presumably due to confusion of the enthalpy of lattice formation with the required enthalpy of lattice dissociation. About half of all students gave a correct answer to part (e). Answers to part (f) were often wrong. The usual error was a failure to use a factor of 1000 in order to make enthalpy and entropy have the same units. Part (g) was answered well and those students who calculated a negative entropy change in part (f) usually scored full marks.

Question 2

In part (a), about half of all students knew the meaning of the symbol. Answers to part (b) were very disappointing. Answers were characterised by a lack of precise language and a lack of understanding that hydrogen bonds between water molecules must be broken when ice melts. Students are expected to understand that the bonds broken are between the molecules. It is pleasing to report that answers to part (c) were almost always correct. However, in part (d) this ‘how science works’ question was not understood and only 11% of students gained a mark. Part (e), however, was answered correctly by the great majority of students and it is pleasing to report that the concept of colour was understood well, despite the context being unfamiliar.

Question 3

Parts (a)(i) and (a)(ii) were answered correctly by most students. Part (b) proved to be more demanding and only the best students appreciated that the van der Waals’ forces between molecules in P_4O_{10} are stronger than in SO_2. Too many students thought incorrectly that P_4O_{10} was macromolecular or ionic. Part (c) was answered well and more than 80% of students scored at least three marks. As expected, part (d) was a little more demanding and only about 50% of students gained the mark.

Question 4

In part (a), only about 20% of students scored all three marks. In order to gain full marks it was necessary to identify solution **A** as, for example, hydrochloric acid not just as H^+ ions. Part (b) was answered well. Answers to part (c) very rarely scored all three marks. The most common error was to suggest that the salt bridge allowed transfer of electrons rather than movement of ions. Answers to parts (d), (e)(i) and (e)(ii) were pleasing and about half of all students gained the mark in each case.

Question 5

Part (a) was answered well. In part (b), answers were disappointing. Only about 20% of students used data from the table correctly. An effective way of using the data would have been to state that the electrode potential for the chlorine/chloride half equation is more positive than for the oxygen/water half equation. However, in many cases the species involved in the half equation were not mentioned or were in the wrong order. Answers to part (c) were often correct. Answers to part (d) were often disappointing and many students suggested that the oxidation state of hydrogen rather than oxygen was changing. Part (e) required similar understanding and use of electrode potentials as in part (b) and responses were similarly disappointing.

Question 6

The equation required in part (a) is recognised to be discriminating and it proved to be so with only 34% of students giving a correct answer. Part (b) was a 'how science works' question and only 20% of students could explain that a spectrometer can be used because manganate(VII) ions are coloured but the products of the reaction are effectively colourless. Some students tried to use a mass spectrometer. Answers to parts (c) and (d) were pleasing. However, as expected, part (e) proved to be very discriminating and only the very best students could write balanced equations for the two reactions.

Question 7

Parts (a) and (b) were fairly straightforward questions requiring recall of transition metal chemistry and it is pleasing to report that they were answered well by the majority of students. It is also pleasing to report that most students gained the mark for part (c)(i). A correct explanation of the chelate effect in part (c)(ii) was more demanding. Most students knew, or predicted, that the entropy change is positive but only the best students were able to explain how and why the disorder increases. Part (c)(iii) proved to be more discriminating than expected. Only the best students applied the factor of 1000/150 correctly and a surprisingly large number of students did not calculate correctly the relative formula mass of calcium hydroxide. Some used the M_r for EDTA and some the M_f for CaOH.

Question 8

Parts (a) and (b) were usually correct. Part (c) proved to be more difficult than part (b). Weaker students gave an ammine complex with six rather than four ammonia molecules and the charge of the ammine complex was often incorrect. Part (d) was very discriminating. Only the best students identified the initial green precipitate as a form of iron(II) hydroxide and went on to explain that this would be oxidised to a brown solid by oxygen in the air. Part (e)(i) was set as a 'stretch and challenge' question and it proved to be so. It was disappointing to find that only a very few students could draw a parallel with the reaction in part (b) and hence predict that aluminium hydroxide would be formed. Part (e)(ii) was very discriminating; most students could gain some credit but only the very best students were able to gain five or more marks out of the six available. Only about 2% of students were able to write a correct equation for the oxidation of the cobalt(II) complex.

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