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General Certificate of Education

Chemistry 2421

CHEM5 Energetics, Redox and Inorganic Chemistry

Report on the Examination

2010 examination - June series

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General Comments

This examination was the first time that the new unit CHEM5 had been examined at the end of a school year. The standard of the paper proved to be similar to unit CHEM4 and also similar to unit 5 papers in the previous specification. Examiners were generally pleased by the performance of candidates.

Question 1

It was surprising that only about half of candidates answered part (a) correctly. In many cases, either state symbols were incorrect or the products were not ions. In part (b)(i) the majority of candidates lost a mark because they failed to mention that all substances must be in their standard states. Answers to part (b)(ii) were also disappointing. Again state symbols were often wrong and also fluorine was not shown as F_2. Good candidates were successful with part (b)(iii) but weaker candidates often scored zero. The most common mistakes were a failure to multiply the electron affinity by 2 and incorrectly using twice the bond enthalpy of fluorine, presumably because it was confused with enthalpy of atomisation. Only the very best candidates gave sensible explanations in part (c). Other candidates often referred to intermolecular forces showing a lack of ability to use Unit 1 material. Answers to parts (d)(i) and (ii) were of a higher standard. Most candidates made progress with part (e) but weaker candidates often incorrectly offered an explanation for the colour of a compound caused by transmission of some visible light rather than suggesting that visible light is emitted after the UV light has been absorbed.

Question 2

This question proved to be a little easier than question 1. Most candidates gave correct explanations in part (a) but weak candidates did not make a clear distinction between molecules and a macromolecule. Parts (b) and (c) were answered well but part (d) proved to be more testing and a significant number of candidates gave no answer. Most candidates answered part (e) correctly. As expected part (f)(i) was more challenging and in part (f)(ii), only the very best candidates could write a correct, balanced equation. It was pleasing to find that part (g) was usually correct.

Question 3

Part (a) was answered well but part (b) was more difficult and weak candidates confused ions with atoms. In part (c) it was disturbing to note the large number of candidates who gave a wrong formula for the sulfate ion produced, usually showing only a single negative charge. Part (d) was answered well. Part (e) proved to be challenging, especially the equations. Only the best candidates could write balanced equations, the most common error being to use only one mole of iron ions, despite requiring two moles of electrons for reaction of the $S_2O_8^{2-}$ ion and for the formation of I_2. In part (f) most candidates attempted to answer in general terms by mentioning activation energy rather than giving an answer specific to iron(II) and iron(III) ions.

Question 4

Candidates answered this question very well and demonstrated a good understanding of these aspects of transition metal chemistry. The only parts of the question that had a facility less than 65% were parts (c) and (d)(iii). In part (c) a significant number of candidates stated that the red colour was due to emitted light rather than light transmitted after other colours had been absorbed. Part (d)(iii) proved to be more challenging and weaker candidates simply stated that a multidentate ligand created a more stable complex. They lost marks because they did not refer at all to entropy.

Question 5

This question proved to be much more difficult than the other transition metal question. Many candidates were not able to describe the appearance of **W**, **X**, **Y** and **Z** and were also unable to write correct, balanced equations for the reactions. In part (a) the colour of the $[CuCl_4]^{2-}$ ion was not well known. In part (b), the colour was sometimes given but without the physical state. A 'blue solid (or precipitate)' was required for the answer. To give just 'blue' was not accepted as a correct description of the appearance of **X**. Many candidates gave an equation using OH^- ions. The correct answer required the use of ammonia in a single equation or as part of two equations where the OH^- ion was formed by reaction of ammonia with water. Answers to part (c) were rarely correct. Only the best candidates answered the question correctly and showed formation of the $[Cu(H_2O)_2(NH_3)_4]^{2+}$ ion from **X**, the hydroxide precipitate. The chemistry in part (d) was not well known. Answers to part (e)(i) were of a higher standard but in part (e)(ii), very few candidates could give two correct environmental reasons. Many candidates referred to scrap iron even though the question specifically asked for reasons other than the use of scrap iron.

Question 6

In this question, parts (a) and (b) were answered well but the remainder of the question proved to be much more difficult. In part (c) the most difficult part of the question concerned an explanation why the reaction was not feasible at high temperatures. Candidates were expected to argue that, because the entropy change was negative, the term $-T\Delta S$ was positive and large at high values of T so that the entropy effect would more than compensate for a negative enthalpy change leading to positive ΔG values. Only the best candidates were able to argue in these terms. The calculation of temperature caused problems for weaker candidates who failed to use the factor of 1000 to ensure that ΔH and $T\Delta S$ were in the same units. In part (d) it was rather distressing to discover the large number of candidates who were unable to write a balanced equation for the combustion of methanol. Some candidates did not read the question carefully and failed to register that the combustion was in the gas phase. Answers to part (e) were very disappointing. Candidates should realise that re-stating the question to suggest that the reactants are not carbon neutral is not sufficient to gain a mark. Also, it was not generally recognised that the term 'carbon neutral' refers not to carbon but to the balance of carbon-containing gases in the atmosphere.

Question 7

This was the most difficult question in the paper. In part (a) most candidates knew that a standard hydrogen electrode uses hydrogen gas and a platinum electrode but only a minority went on to state the correct and necessary conditions of concentration, temperature and pressure for operation of the electrode. In part (b) most candidates gave a correct value for the electrode potential of the positive electrode but very few candidates were able to use the cell representation to deduce a half-equation for the electrode reaction. Answers to part (c) were also disappointing. Despite the given electrode potentials and half-equations, most candidates could not predict and explain the redox reaction between hydrogen and iron(III) ions. Part (d) also proved to be a difficult question. Candidates were usually able to score three marks out of six for a correct calculation of the number of moles of dichromate(VI) ions, a calculation of the original number of moles of iron(II) sulfate and for recognising the involvement of a factor of ten. Only the very best candidates realised that the number of moles of iron ions was six times the number of moles of dichromate(VI) ions and that a subtraction was required to calculate the percentage of iron(II) ions that had been oxidised by air before the titration.