Feedback on Questions

Question 1

The first question started with a consideration of oxidation states of elements and their use in the completion of an empirical formula. Most candidates completed this very well, getting off to a good start.

Part (b) required the careful drawing of three structures. 2-Ethylhexan-1-ol (the "2" is of course redundant, but we left it in for clarity) and phosphoric acid were the easy marks, but the best candidates managed to draw an analogy between regular, carbon-based esters and their phosphate counterparts and came up with a structure for DEHPA. We were quite generous with these structures, as long as they were chemically sensible and consistent.

The equations were quite challenging to balance, and the teachers amongst the committee think these could be used as some examples for G&T students in our own schools!

Part (d) was a straightforward, AS Hess' Law cycle – typical L6th exam fodder – and was well-completed by most.

The two crystal-structure parts of the first question were the most challenging, and the subject matter is not in a typical L6th course. However, given past questions in C_3L_6 papers (eg the determination of N_A in the 2011 paper), we hope that L6th students will gradually become familiar with this important area of the subject. We hope that those who had never come across the concept of the unit cell will have been able, with the application of simple mathematics, logic and common sense, to score a good number of marks in this section. Remember our comments in last year's report about "resilience" – an important faculty for the best scientists.

The last part of this question moved from science fact to science fiction! Those candidates who really understood thermodynamic cycles at AS were able to see how these could be applied to the determination of the enthalpy changes associated with some interesting transformations. The two parts that dealt with bond dissociation enthalpies could be worked out, but perhaps not fully rationalised, by an AS student. The part that dealt with the dilithium cation could have been tackled by comparing it with the hydrogen molecule – removing an electron might be expected to weaken the bond, and make the bond longer. The diberyllium cation value (from calculation) should be compared with the value given for diberyllium in the question, and the conclusion drawn that the bond is stronger (and therefore shorter). The reason for this needs an appreciation of molecular orbital theory to fully understand it, and keener students could be directed towards an introductory university text (such as *Why Chemical Reactions Happen* by Keeler & Wothers!).

Question 2

We recognised that not all students have encountered skeletal formulae, and therefore we explained them in the introduction. An appreciation of this enabled the first part of this question to be completed.

The protonation of the nitrogen atom in part (b) was not well-understood – few appreciated that the nitrogen atom is basic, because most failed to draw a link between ammonia and the ammonium ion.

Most candidates should have been able to recognise H^- as a nucleophile, given the AS definition as a lone pair donor. The conversion of **A** to **B** could be determined as a reduction reaction, given that it is the reverse of a reaction that is on AS: the oxidation of a primary alcohol to a carboxylic acid.

Part (d) was tricky, but there was a logical process that would enable the best students to get through to the solution. The first reaction of **A** with "normal" $LiAlH_4$ followed by D_2O gives a product that is not **B**, but **B**[1]. Given that the nucleophile, which must be the source of the CH_2 hydrogens in the product, is "normal" hydrogen, should lead a candidate to the idea of exchangeable protons. Hence structure **4**, or better, **5** is the solution. This should lead then to the solution to (d)(ii) being structure **3**.

The assignment of the IR frequencies was done by looking at differences between compounds, rather than any prior memory of particular stretching frequencies.

The isomer question was well-answered by most.

Parts (h), (i) and (j) were fairly straightforward and, as long as some rudimentary mathematics was remembered, the peak height in (j)(ii) was easily determined.

The final parts about the uric acid assay were well answered, as long as the candidate had struggled through to the end of this intentionally gruelling paper. All should be encouraged to keep going to the end, and not give up!