REPORT ON THE CHEMISTRY OLYMPIAD ROUND 1 PAPER 2005

The very helpful and largely positive comments that we have received on this year's Olympiad paper suggest that we have again managed to set a paper which is interesting and hugely challenging to sixth form students and much appreciated by teachers. Although we use the results of this test to select the students who proceed to Round 2 and eventually into the UK Chemistry Olympiad team we hope that it does more than that: it should promote Chemistry as a relevant and exciting subject and stretch the most able students in the sixth form who may find A levels undemanding.

It was certainly a difficult paper but we were very impressed with the results. Almost 1000 candidates from over 300 schools sent in scripts, and there was a good distribution of marks: 8% of candidates were awarded a gold certificate for scoring more than 40 marks out of 66 (one candidate achieved a remarkable 64/66!), 18% got silver certificates for between 30 – 40 marks, and 35% got bronze certificates for marks between 20 - 30. There were many other creditable performances outside of this range, and only a very small number of candidates (6%) who failed to score double figures.

An encouraging number of scripts were received from students in the lower sixth. The top mark for a lower sixth student was 47/66 which was very impressive.

Comments on individual questions are given below.

Question 1: carbon oxides

There were some good answers but it was surprising that many candidates could not write correct equations for the reaction between calcium carbonate and hydrochloric acid, and between aqueous palladium chloride and carbon monoxide where the water is essential to make chemical sense. Candidates could often draw a 'dot-cross' diagram for carbon monoxide but then did not always appreciate that the bonding between carbon and oxygen was a triple bond. Too many did not fully dehydrate propan-1,3-dioic acid so thought that carbon suboxide would contain hydrogen. The last part on the dehydration of benzene hexacarboxylic acid to $C_{12}O_9$ was well done.

Question 2: iodine pentoxide

We were slightly surprised that this question was not well done. The calculation of the percentage of carbon monoxide in the mixture should have been straight forward. Answer booklets showed lots of working in part (c) including the correct mole ratio of water to iodine oxide, but there were few correct answers to the empirical formula which must be the **simplest** whole number ratio of the numbers of atoms. Good structures were drawn in parts (d) and (e) but the equation in part (f) was demanding.

Question 3: ants

This was probably the most accessible question on the paper: candidates who had not studied the material before were given sufficient information to do the calculations. The question was well done on the whole, with the exception of the equation for the reaction between methanoic acid and sodium hydrogencarbonate which frequently produced 'impossible' products such as sodium metal or sodium carbonate. The number of ants needed to produce 1.0 dm^3 pure methanoic acid ranged from 2.67 (watch how you pick up one of these!) via 266667 to 6.4 million without very much common sense or feel for significant figures.

Question 4: NanoPutians

We knew that this would probably be the most demanding question on the whole paper but we wanted to include it; nmr is a very useful tool for Chemists and we hope teachers might use this question in future in their teaching. The most able students were able to look for symmetry in the structure to deduce the number of expected nmr peaks, but hardly anyone (teachers and scrutineers included!) realised that carbons 40 and 41 were slightly different because of the three-dimensional shape of 'NanoBalletDancer'. There was a great deal of reading necessary to explain nmr to those who had not studied it, but those who persevered and tried to assign peaks correctly in the proton nmr by thinking rather than just guessing them were rewarded with high marks.

Question 5: breathalyser

This proved to be a good discriminator where the strongest candidates did very well but the weakest could not manage to write or combine the relevant half-equations correctly.

Question 6: Rimonabant

This was another demanding question, but most students scored the first two marks for the structures of chlorobenzene and propanoyl chloride. Many candidates got stuck in the middle of the problem and gave up, but the best seemed to work forwards and backwards and therefore also got credit for the structures in the last three stages. It was surprising how some students thought that weird rearrangements might occur (such as a Cl somehow just changing its position on a benzene ring). This makes no chemical sense, and we would encourage students to keep as much of the carbon framework in the structure intact as possible; they should also look for elements in the final structure (such as the hydrazine molecule) and put these different pieces together to see what has happened. The equations for the reactions gave all the products, so it was possible to work out formulae for each structure with the information given.

All committee members hope that students enjoyed the experience of attempting a really demanding paper and that teachers will use questions (and answers!) in their teaching. We hope that more schools and more students will be encouraged to enter the competition next year. A number of teachers wished to enter more than five scripts this year or found it difficult to choose the best five from their candidates. It is likely that next year we will provide the mark scheme

on request to teachers; schools will be able to enter any number of marked scripts for consideration for certificates, but only the top five from any centre will be remarked for possible selection for Round 2.

Tim Hersey
Chairman of the UK Chemistry Olympiad Selection Committee