



Cambridge Chemistry Challenge Lower 6th

Feedback on Questions

Question 1

This question was inspired by the visit to Canada of one member of the Committee, who was given a bottle of water that, it was claimed, contained O_4 molecules. After considerable research into the literature, we discovered some reports of unstable tetraoxygen and decided this would make a fun question. Part (a) was designed as an easy introduction, using ideas of redox from AS Chemistry. We accepted the underlining on the left or right, or both sides of the equations. An alternative answer to Part (ii), involving the production of carbon monoxide was occasionally seen and accepted.

The diagrams in Part (b) could be written in various ways and anything chemically correct was accepted. Most candidates got the formulae of the species correct, even if their diagrams were not. For Part (c) a common mistake was misreading nitrate(III) for nitrate(V) and therefore giving the answer O_4 . Apart from ozone, other correct answers were CF_2 and NOF (both of which occurred candidates' scripts).

A common error in 1(d) was to work out the standard enthalpy of formation for the puckered ring O_4 rather than the activation energy for the formation of puckered ring O_4 from O_2 . When tackling questions such as this in the future, candidates should be encouraged to draw enthalpy level diagrams, as shown in the mark scheme. The key to answering Part (f) is a consideration of the symmetry of the various structures given in the paper. It should be remembered that peaks A and B on the mass spectrum are fragment ions derived from peak C. The absence of any peak corresponding to $^{16}O^{18}O^+$ ($m/z = 34$) suggested to the original investigators that the square, pinwheel, and puckered ring structures were unlikely, because their fragmentation could scramble the oxygen isotopes into the mixed dimer.

In unstructured calculations such as the time-of-flight experiment considered in Part (g), it is important that candidates keep careful track of units. A common mistake was candidates' failure to convert g to kg or to realise they needed to use the mass of the $^{18}O_4$ molecule in kg, rather than the relative molecular mass.

Question 2

The rationale for setting this question was to introduce candidates to the important skill of following connectivity in complex reactions. This is a useful technique employed by Organic Chemists when they are keeping track of their molecules during the consideration of synthetic schemes: this approach is rarely utilised by students at this level. The cyclisation reactions in Parts (e) to (j) were challenging and so we included more assistance on how to approach the questions. Despite the amount of material to take in, especially under examination conditions, the best candidates tackled this question admirably and we hope that it will be of use as a teaching tool in the future. The building up of complex natural products from simple isoprene units is a ubiquitous pathway in Biochemistry. Candidates interested in exploring this further could be directed towards Chapter 51, of *Organic Chemistry*, by Clayden, Greeves, Warren and Wothers!