

# Principal Examiner Feedback

## January 2009

GCE

### GCE Chemistry (6242) Paper 01

## 6242/01

### General

This paper contained questions accessible to all candidates as well as more testing questions and questions requiring them to construct a coherent explanation. Many candidates found several parts of this paper difficult but, as in previous years, compounded their problems by failing to read questions carefully enough and by failing to express themselves clearly. It is obvious that many candidates have a very superficial understanding of the subject and have learned forms of words from previous examination mark schemes, so that, when the question requires something slightly different, their lack of real understanding is exposed. Many candidates had not learned basic definitions in clear concise terms.

Organic chemistry, as usual, divided candidates into those having a good knowledge and understanding, and those who seem to have little or no knowledge. It is of particular concern to see so many organic formulae in which carbon forms more than four bonds. This was particularly the case with the formulae for alkenes.

Candidates should be reminded that, if they are continuing their answer somewhere else on the paper, they should make this apparent. They should also remember to cross out their initial answer if they change their mind. A significant number of candidates had been provided with continuation paper (sometimes an 8 page answer book) solely for rough work, which rarely, if ever, scored marks and which would have been more meaningful alongside the answer. This practice is strongly discouraged.

### Question 1

This question required candidates to recall the conditions for the Haber Process and to apply their understanding of energetic and kinetics to the reaction.

Many perfect definitions were seen, but, many candidates did not heed the question and gave a general definition of standard enthalpy of formation. Some confusion between standard states and standard conditions was apparent and many answers either omitted to state what the standard conditions are or gave incorrect figures.

All but the weakest candidates were able to carry out the straightforward calculations in (a) (ii) and (iii) and the majority showed working. Common errors were to miscount the numbers of each types of bond involved, to reverse the signs of the enthalpy changes, and to make simple arithmetical errors, commonly due to candidates misreading their own, untidily written, numerical values.

Very few candidates were able to answer (a) (iv) satisfactorily. Vague, poorly expressed answers were the norm with reference to average bond energies without specifically mentioning the only bond in this reaction, N-H, that has an "average" bond energy. Candidates often suggested that one was an experimental while the other was a theoretical value or referred to experimental sources of error such as heat loss.

The majority of candidates scored marks for the conditions in the Haber process but explanations of why high pressure plants are expensive were usually vague.

Many good explanations of the effect of pressure on the equilibrium were given, with fewer candidates than previously giving Le Chatelier type explanations in terms of reducing the pressure.

The majority of candidates were able to score at least two marks for the reaction pathways in (b) (iii) and a pleasing number of candidates scored the third mark by showing the catalysed reaction in two stages. Some candidates labelled the intermediate incorrectly as “catalyst” or even “iron”.

The majority also scored at least two marks in (b) (iv) by marking the  $E_a$  correctly and explaining the increase in rate. A small number of candidates showed confusion with the Maxwell-Boltzmann distribution at different temperatures, either in their graphs or in suggesting that the number of collisions increased. Only the very best candidates scored the third mark by correctly describing the significance of the areas beyond  $E_a$ .

## Question 2

This question required candidates to recall and apply their knowledge of the chemistry of alkenes and alcohols.

Very few candidates could not prove the empirical formula of the alcohol, though a minority lost marks by not showing the division through by the smallest to obtain the whole number ratio.

The majority of candidates were able to correctly identify W as a tertiary alcohol, though several candidates *drew* the branched primary alcohol. In drawing the three structural isomers a disappointing number of candidates drew the same isomer more than once with different shapes, often missing the branched alkene, losing marks in (b) (ii) as a consequence. Many structures with pentavalent carbons were seen. The better candidates were able to correctly identify the alkene, though many lost the mark by an unsuccessful attempt at naming it. Rather fewer were able to give a concise, coherent reason for their choice. Candidates tried to describe the process of dehydration rather than the relationship between the carbon skeletons. The *cis* and *trans* isomers were drawn correctly by the majority of students. More correct explanations of the origin of geometric isomerism were seen. Some candidates find it difficult to express this idea clearly, some implying that rotation of the double bond or molecule is necessary for isomerism, while others did not make it clear that two different groups are required at both ends.

Part (d) was very poorly answered by the majority of candidates. Most, not reading the question thoroughly, did not take into account that the alcohol must relate to the branched alkene. The commonest answer was the wrong primary alcohol, butan-1-ol. Of those candidates who identified the correct alcohol, a high proportion then went on to give the straight chain carboxylic acid.

## Question 3

A straightforward question on polymerization and the bonding changes involved.

Many candidates described free radicals as having lone electrons or lone pairs or as being ions. Several candidates defined homolytic fission and it was not uncommon for candidates to describe the radical as “an unpaired electron”. Most candidates were able to state the necessary condition for radical formation in this reaction.

In (b) (i) many candidates did not read the question and failed to give an equation for the formation of polypropene, losing two marks by simply giving the repeat unit. It is pleasing to report that fewer candidates, but still a significant minority, included the methyl group in the polymer backbone or showed a repeat unit with the double bond intact. Many incorrect formulae were seen for propene, showing pentavalent carbon.

Many candidates who gave an otherwise correct answer were unable to correctly balance the equation using  $n$ .

In explaining why the reaction is exothermic, many candidates gave general answers and failed to refer to the bonding changes in this particular reaction. This topic is not well understood by a large number of candidates; references to “energy required to make bonds being greater than the energy required to break bonds” were disappointingly common. The most able candidates were able to answer this question clearly and concisely with correct reference to  $\sigma$  and  $\pi$  bonds. Weaker candidates did not understand that one  $\pi$  bond is being replaced by one  $\sigma$  bond (or that one double bond is replaced by one single bond) and suggested that two or more single bonds replace each double bond. References to the formation of new C-H bonds were not uncommon.

A surprisingly large number of candidates did not attempt an answer to (b)(iii). The minority of candidates mentioned a high activation energy and many of these then lost marks by going on to say that the initiator provided this energy.

#### Question 4

This question required candidates to recall the electrolytic extraction of aluminium, and to carry out a straightforward calculation related to it.

The majority of candidates tackled the calculation in (a) (i) using moles rather than by the much more straightforward mass ratio method. Most candidates were able to arrive at a correct answer. It was pleasing that far fewer candidates than previously had difficulty in using tonnes in a calculation, though several misapplied, or failed to use, the stoichiometry in the equation. Weaker candidates were confused by the percentages and attempted to use them in this part of the calculation, rather than in (a) (ii), which proved accessible to only the most able candidates. The best candidates, as usual, showed clear working and explanation, but many candidates are still failing to do so.

The conditions for electrolysis were well known but many candidates were unable to give a convincing reason for not using pure alumina; its expense was often cited. Many candidates correctly stated that it has a very high melting point, often stating a value, but failed to explain that this is a problem in terms of the energy required.

Most good candidates were able to score good marks on the ionic equations for the electrolysis. Weaker candidates often put electrons on the wrong side of one or both equations, or could not balance the number of electrons, particularly for the anode reaction. Many incorrect ionic and molecular species appeared in equations eg  $\text{Al}_2$ ,  $\text{O}^-$ ,  $\text{O}_2^-$ , and atomic oxygen O.

All but the weakest candidates could explain the reasons for replacement of the anodes, give a correct equation and state the major cost in the process.

## Hints for Revision

- Take time to learn basic definitions from organic chemistry, and those for the main (standard) enthalpy changes in clear, concise and precise language. If you mention standard conditions state what those conditions are.
- Practise writing electrode equations for the main industrial processes met in the course. Use the idea of charge conservation to check that electrons are on the correct side.
- Practise drawing and labeling enthalpy profiles for catalysed and uncatalysed reactions and labeling activation energies and  $\Delta H$ .
- Practice drawing the Maxwell-Boltzmann distribution of molecular energies and marking Activation Energies correctly. Learn to describe the significance of the areas under the graph, beyond  $E_a$ , in explaining changes in reaction rate.
- Whenever you draw the full structural formula for an organic compound, check that the valency of carbon is 4. Similarly check the valency of other common atoms (hydrogen 1, oxygen 2, nitrogen 3). Also check that you have drawn the bonds carefully between the correct atoms, for example in alcohols the bond from carbon must be to the O of the OH group.
- When drawing isomers for organic compounds, check that you have not drawn the same isomer more than once with the carbon chain folded differently or seen from the opposite end. It is helpful to check the names of the isomers you draw in order to eliminate duplicates.