

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Report on the Units

June 2007

3882/7882/MS/R/07

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

The reports on the Examinations provide information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the syllabus content, of the operation of the scheme of assessment and of the application of assessment criteria.

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Advanced Subsidiary GCE Chemistry (3882)

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Chief Examiner's Report

General Comments

This June's session continued to see entries rise across all units. For AS-level aggregation, entries increased from 14192 in June 2006 to 14835 for June 2007. For A-level aggregation, entries increased from 10291 in June 2005 to 11113 for June 2007. For Chains and Rings, and How Far? How Fast?, there were about 20000 entries.

The overall standard of work increased with a slight improvement in results for most units. For A-level aggregation, the number of A grades awarded rose by more than a percentage point.

The most popular optional units continue to be Biochemistry and Transition Elements, with the strongest cohort of candidates taking Transition Elements.

Most units discriminated very well between candidates of differing abilities. Re-sit entries seem to have increased. This is most apparent for Chains, Rings and Spectroscopy with more than 50% of the entry being made up of re-sit candidates from January 2006. Foundation Chemistry contained two cohorts of re-sits, those in their AS year, presumably after a disappointing result from January 2007; and those completing their A level course. It should be noted that weak AS candidates often fail to enhance their original result. A2 candidates though can increase their Foundation Chemistry result considerably by re-sitting at the end of the course

The Practical Examinations both performed well although there were two problems. For AS, some centres experienced problems with identifying the required colour change of the indicator. As problems seemed to have been centre-specific, this could have been attributed to an impurity present in the indicator. For A2, there was an unfortunate misprint of a concentration on the first page of the Test. Fortunately this was not critical as the correct value was shown later in the test correctly in a question in which the value was to be used. An erratum was dispatched to centres. In both cases the Examiners took care to ensure that candidates were not disadvantaged. For example, the accuracy requirement for the AS titration was made less rigorous to take account of the problem with the colour change.

Entry to modules

Centres are again reminded of the codes that are to be used for entry in those units of assessment with more than one component. Note that 2815/05 will no longer be offered owing to the very small entry. 2813/03 is only offered in the June session for the same reason.

AS

2813	A	How Far, How Fast? + Coursework
2813	B	How Far, How Fast? + Carry forward coursework mark
2813	C	How Far, How Fast? + Practical Examination

A2

2816	A	Unifying Concepts + Coursework
2816	B	Unifying Concepts + Carry forward coursework mark
2816	C	Unifying Concepts + Practical Examination

Options

2815	A	Trends and Patterns + Biochemistry
2815	B	Trends and Patterns + Environmental Chemistry (<i>June entry only</i>)
2815	C	Trends and Patterns + Methods of Analysis and Detection
2815	E	Trends and Patterns + Transition Elements

Upcoming INSET events

Get Ahead – ideas and approaches for improving candidate performance.

Course dates and codes – Saturday 13 October 2007 (London, CCHE101), Thursday 8 November 2007 (Birmingham/Coventry, CCHE102), Friday 23 November 2007 (Manchester, CCHE103).

Fee – £160 including refreshments, lunch and course materials. £190 if you book within 7 days of the course date.

Get Ready – free half day sessions aimed at all those interested in finding out more about OCR's new AS/A level specifications in Chemistry A and Chemistry B (Salters).

Course dates and codes – Wednesday 12 September 2007 (Plymouth, CCHE301), Tuesday 18 September 2007 (Birmingham, CCHE302), Friday 28 September 2007 (York, CCHE303), Tuesday 9 October 2007 (London, CCHE304), Tuesday 13 November 2007 (London, CCHE307), Wednesday 21 November 2007 (Newport, CCHE305), Friday 14 December 2007 (Manchester, CCHE306), Friday 11 January 2008 (Birmingham, CCHE308), Thursday 17 January 2008 (Bristol, CCHE309), Friday 25 January 2008 (Leeds, CCHE310).

Fee – This course is free. If you book then you find you cannot attend, you can substitute a colleague at any time.

Places may be booked on these courses using the booking form available on-line (www.ocr.org.uk/Data/publications/training_booklets/AS_ALevel_INSET_Chemistry.pdf). Please quote the course code in any correspondence.

2811: Foundation Chemistry

General Comments

The paper appeared to generate a wider range of marks with more candidates scoring poorly than in previous years. It is noteworthy that throughout the paper candidates appear much more secure in their knowledge of covalent bonding and the properties of covalent compounds than they do in those of ionic substances. So, for example, requests for a 'dot-and-cross' diagram for H_2O_2 or a rationale of the geometry of NCl_3 were refreshingly well answered. Likewise the bonding in graphite was clearly well understood. In contrast there were too many candidates who gave covalent Na_2O molecules as answers to 2(b), who failed to gain both marks when discussing the decrease in electrical conductivity in 4 b(iii) and who referred to molecules of sodium chloride or intermolecular forces in sodium chloride in the final question.

Comments on Individual Questions

- 1) (a) The paper opened with two relatively easy marks that were picked up by almost all candidates. Although the majority chose to draw a single p orbital some candidates showed two or three orbitals set along the appropriate axes.
- (b) A very large proportion of candidates failed to read the first part of this question correctly and gave the number of electrons in a d sub-shell rather than a d orbital, despite orbital being in bold type. In fact, nearly all candidates who scored 13/14 had this slip to blame for not gaining full marks on the first question. A more serious error was revealed by candidates' answers to the last part, where many gave the number of electrons in the third shell as 8 rather than 18. This answer has its origins in the GCSE course and shows that for these candidates their understanding of electronic structure has advanced little from this stage.
- (c) This part was very well answered with almost all candidates gaining both marks. The only repeated errors that were evident were the use of 3p in place of 2p and the placing of the four p-electrons as pairs in two orbitals.
- (d) (i) As always this should have been very familiar territory and indeed many candidates used the opportunity of a predictable question to move forward by three marks. This said, however, it is still surprising how many candidates will not give the time to learn this definition fully. The most common error was to allow an inequality between the number of atoms and the number of electrons that must be removed.
(ii) Candidates found this part of the question relatively challenging and despite having given a good definition in part (i) they were unable to put the definition into practice. The mark for the correct state symbol was the easier of the two to obtain, for candidates clearly felt more at home with an oxygen anion rather than a cation and with O_2 in place of O, these two being the most commonly

observed errors.

(iii) This was generally well answered. Most candidates noted the large increase between the 6th and 7th ionisation energy although some did not look sufficiently far along the table and used the change from the 4th to 5th ionisation energy as their evidence. Almost all candidates were able to link the large change in ionisation energy to the presence of a new shell of electrons.

- 2) (a) This series of short calculations was well handled with many good candidates gaining all four marks. In part (ii) there were answers where the stoichiometry of the reaction had not been taken into account and so twice the correct quantity of hydrogen had been used but the number of candidates making this error was pleasingly very small.
- (b) In general this was well answered, although it is always depressing to see any candidate at this level propose a covalent structure for a species so obviously ionic as sodium oxide and, of course, there were a number of such errors.
- (c) (i) The first equation was much easier than the second and the vast majority of candidates obtained this mark. The most common error was to use Na₂ in place of 2Na.
- (ii) The second equation was much more challenging. Few candidates used the full information given in the question and so although they generated hydrogen peroxide they did not form an alkaline solution. This error led many to react the peroxide with only one equivalent of water to yield H₂O₂ and Na₂O.
- (iii) This question which initially looks rather daunting was extremely well answered, even to the extent where some weak candidates would only pick up these two marks in the entire question.
- 3) (a) Many candidates knew that the addition of silver nitrate was the correct answer to this part and virtually all of these knew that silver chloride would be white. It came as no surprise, however, how few of these candidates were then able to go on to give a correct equation for the reaction. Many equations failed to balance in terms of the species involved and more seriously some involved Cl₂ in place of Cl⁻.
- (b) This was probably the most poorly answered question on the paper with only the really able candidates recalling the reagent needed to form bleach. The majority of these candidates went on to give correct equations for the disproportionation involved.
- (c) In the main this was well answered and there seemed a degree less confusion here than there has been in previous years. Very many candidates correctly identified the trend in the strength of the van der Waals' forces although fewer linked this to the increase in the number of electrons. Weaker answers often focused on the increased mass of the halogen as the group is descended.
- (d) (i) This was very well answered. Of the possible errors, trigonal planar was seen more often than tetrahedral.

- (ii) As in part (c) the answers to this part seemed improved on recent years. Some candidates rushed the answer slightly and thought the presence of the lone pair sufficient explanation for the geometry of NCl_3 , but many took their time and gave excellent answers.
- 4) (a) (i) Almost all candidates correctly responded here, although some felt the need to add comments about the number of electrons which may suggest that the definition of atomic number was not as secure in their minds as it might have been.
- (ii) Again this was well answered with only a few candidates giving incorrect answers more often than not proposing either the alkali or alkaline earth metals.
- (iii) Once again many candidates felt they were in familiar territory and the two marks for the greater nuclear charge and its consequent increased attraction were picked up easily. Fewer answers discussed shielding or the location of the electrons in the same shell. As in previous years it is this last marking point which was less commonly awarded.
- (iv) The vast majority of candidates knew that barium would form a cation and so become smaller but far fewer were able to give a good reason why this would be the case. Many erroneously proposed an increased nuclear charge in the barium ion while some simply thought the fact that it formed a cation was explanation enough. Of those who did score the second mark it was notable how few went for the simplest answer which is the loss of the outer shell.
- (b) (i) and (ii) Almost all serious candidates pick up these marks.
- (iii) In general this was poorly answered and revealed two main points. The first is that many candidates do not really understand what happens to ionic compounds when they form aqueous solutions. The second is that many candidates associate electrical conductivity exclusively with the movement of only electrons. These points were reinforced by candidates' answers to the final question (*vide infra*).
- (c) The majority of able candidates had no problem with this question and calculated with ease the mass of barium metal that could be produced. More noticeable than in previous years was the number of candidates who used the alternative method involving the equivalent masses of 6BaO and 3Ba . It was not uncommon that candidates embarking on this second method then also applied the 2:1 ratio and so generated an incorrect answer. There were, of course, a number of candidates who were unable to progress much beyond working out the amount of BaO but this number was relatively small.
- 5) Overall the quality of answers to this question was reasonably impressive. Of the two substances, more often than not, graphite was the winner in terms of the ability of a candidate to rationalise its properties. Almost all candidates knew that the bonding in graphite is covalent and that it has delocalised electrons which allow it to conduct electricity. Many went beyond the requirements of the mark scheme and discussed the weaker interactions between the layers contrasting with the strong covalent bonds, the strength of which they linked to the high melting and boiling points. The final mark associated with the properties of graphite was for explaining its lack of solubility in water and this candidates found much more difficult, with many resorting to

rather confused responses. The marks associated with the properties of sodium chloride were not awarded as frequently. As noted previously many candidates revealed the fact that they do not have a sound understanding of the nature of ionic compounds. This was perhaps most clearly illustrated by the number of candidates who having gained the first mark for identifying the bonding as ionic then went on to contradict themselves by discussing sodium chloride molecules or the strength of intermolecular forces in the solid. Again when it came to describing sodium chloride's insulating properties many candidates noted the lack of any free electrons but omitted an appropriate comment about the ions. Many candidates identified the fact that strong bonds break when NaCl melts while the final mark concerning the solubility of the salt was mostly picked up by candidates referring to the polar nature of water and very rarely to the interaction of the ions with water molecules.

2812: Chains and Rings

General Comments

The paper produced a spread of marks ranging from 0 to 60. It was pleasing to see a number of candidates score maximum marks. Very few scored below 10, equally the top 3 or 4 marks were elusive. Weak candidates found the paper challenging and a substantial number scored between 10 and 20, whilst able candidates coped well and many scored between 45 and 55.

The majority of candidates seem to have been well prepared. Candidates displayed good examination technique in all of the questions and there was no evidence to suggest that candidates ran out of time.

Each of the five questions was accessible to all students, but each question contained parts that stretched even the most able candidates.

Comments on Individual Questions

- 1) (a) This part was very straightforward, with most candidates scoring all three marks. However, a substantial number wrote an equation for heterolytic fission to show the movement of electrons and didn't include the charges.
e.g.: $\text{Br}_2 \longrightarrow \text{Br}^{\ominus} + \text{Br}^{\oplus}$
 - (b) (i) Most scored the mark but a substantial minority failed to score.
(ii) This was generally poorly done. Very many gave branched isomers as part of their answer.
 - (c) Candidates were well prepared and many scored full marks for the mechanism.
 - (d) (i) This part was very straightforward with almost all scoring the mark.
(ii) This part was more demanding and many failed to express themselves clearly and concisely.
- 2) (a) The majority scored both marks for drawing the isomers, although a substantial number drew the same isomer twice whilst others re-drew either butan-1-ol or butan-2-ol, or both.
Many lost a mark by making careless errors in the naming of their isomer.

- (b) Most score well with 2 out of 3 being the most common mark. Very many gave methylpropene as a possible isomer and many failed to spot that but-2-ene has *cis* and *trans* isomers.
- (c) (i) This was surprisingly difficult with only the most able scoring the mark.
(ii) This was straightforward but with some interesting spellings of effervescence.
- (d) This was easy recall and many scored all three marks, but many lost a mark by omitting the need for an acid or by quoting an incorrect oxidation state for the dichromate.
- (e) Parts (i) and (ii) were straightforward but many failed to appreciate how the choice of apparatus can affect the final product. Only the most able candidates scored both marks.
- 3) (a) The reaction between chloroethane and NaOH is direct recall from the specification but very many knew neither the conditions nor the type of reaction.
(b) (i) This was strangely very poorly answered.
(ii) Good candidates picked up both marks by relating rate of reaction to the different bond enthalpies of C–Cl and C–Br. Weaker candidates tried to explain the reactivity in terms of the relative position of Cl and Br in Group 7.
(iii) This was generally well answered.
- 4) (a) This is a common extended writing question and many were well prepared for it. Candidates should learn to take their prompts from the question. In their responses the examiners were looking for a balanced equation for each process, together with an indication of the industrial conditions followed by a clear statement of the usefulness of the products.
Most wrote suitable equations to illustrate cracking but many chose to crack butane into ethane and ethene and then went on to incorrectly state that the products were 'used as petrol'.
Isomerisation is well understood and many illustrated the process by an equation using skeletal formulae, which is fine, but the equation still has to balance.
Reforming is less well understood. Often able candidates forgot to balance the equation and a substantial minority think that reforming is the reverse of cracking.
Few, if any, stated the usefulness of the hydrogen produced.
Most scored the quality of written communication mark.

- 5) (a) This part was well answered with many scoring all four marks. Many lost a mark by not following the instructions in the question and failed to quote their answer to two significant figures.
- A substantial number misread 'cyclohexene' and answered the question about cyclohexane.
- (b) This was generally well answered but it tended to be two or nothing.
- (c) (i) This was well answered but a common mistake was to draw 1,2-dichlorocyclohexane.
- (ii) This was well answered but strangely many quoted water as a suitable dehydrating agent.
- (iii) Many simple errors cost candidates the mark.
- (d) Able candidates coped well with this and scored either 2 or 3 of the available marks. Many carelessly lost a mark by drawing the same cyclohexadiene twice. Weaker candidates found it difficult to score any marks.
- (e) It was pleasing to see the attempts made by all candidates at the unusual polymer. A substantial number scored both marks. A common mistake was to draw repeat sections of poly(phenylethene) or polystyrene.

2813/01: How Far? How Fast?

General Comments

Candidates, in general, were well prepared for the paper so that correct answers were seen to all questions. Some work was seen that showed real understanding of the chemical concepts involved in the unit but some was seen where it was evident that candidates had attempted to commit the work to memory rather than really understand it. This meant that, when the question asked was not quite as they expected to be, candidates sometimes misinterpreted what was needed. Examples of this are given below.

It was pleasing to note that candidates generally responded very well to the question on the enthalpy changes section of the specification – this included the calculations. However, it was perhaps surprising to note the large number of responses to the question on acids that were disappointing when compared with the general standard of the paper for that particular candidate.

Comments on Individual Questions

- 1) This question was designed to allow candidates to show their knowledge of reactions that are seen across several areas of the unit. It proved accessible so that many candidates scored high marks. Weaker candidates sometimes gave some combination of 'high' and 'low' when asked to quote the temperature and pressure conditions generally used in the Haber process. Others gave numerical values but omitted units.

- 2) As noted above, this question was generally well answered although the inclusion of a calculation on bond enthalpies in a slightly different form did cause difficulty to some candidates.
 - (a)
 - (i) Most candidates had learnt this definition. Occasional errors seen included using 1 mole of elements or carrying out the reaction in the gaseous phase.
 - (ii) Apart from a small number of candidates who wrote an unrelated equation, most could give an equation using elements. Weaker candidates sometimes gave carbon as C_6 and hydrogen as H or H_{14} .
 - (iii) Most answers seen were correct or at least understandable. -289 K was given occasionally.

 - (b) Most diagrams were correct. Candidates who drew a diagram showing an endothermic process were able to access the marks for E_a and ΔH .

- (c) Not surprisingly candidates who drew correct cycles were most likely to complete this calculation successfully. It was obvious that nearly all candidates were familiar with the use of Hess' Law to solve problems of this type.

Ans. -76 kJ mol^{-1} .

- (d) Many candidates failed to recognise that bond enthalpies are defined as the energy needed to break the bond and are therefore positive. This meant that large numbers quoted a correct numerical value, but with a negative sign, in (i). If they went on to use their answer in (ii) this was credited as correct in this part.

Answers

(i) $+413 \text{ kJ mol}^{-1}$

(ii) $+347 \text{ kJ mol}^{-1}$.

- 3) (a) Although clearly there are many ways of stating le Chatelier's principle, most candidates gave acceptable answers. In recent years there have been fewer responses that implied the change to the equilibrium conditions was completely nullified.

- (b) Although the word 'decrease' was given in bold type, some candidates appeared to answer this question as though the pressure was increased. The examiners tried to credit such answers, in terms of the chemical logic shown, but it was sometimes difficult when the candidate did not actually state which change in pressure they were considering.

- (c) Most candidates correctly read the percentage conversion from the graph and were able to interpret it to relate the lowering of the percentage conversion to the rise in temperature.

- (d) (i) Nearly all candidates recognised that a catalyst increases the rate of a reaction and many explained how the catalyst achieves this effect. It was not however acceptable, for the second marking point, merely to state that the activation energy is lowered.

(ii) Some candidates seem to find difficulty with the idea that the rate can increase but that the percentage conversion can remain unaltered. However, many correct answers were seen and an increasing number of candidates were able to explain that this is because the rate of the forward and back reactions is affected equally.

- 4) (a) Most candidates were able to define an acid and quote the difference between 'strong' and 'weak' in this context. It was also pleasing to note how many correct equations, here and in part (ii), were given using the less familiar example of propanoic acid. Examiners accepted equations involving \rightarrow or \rightleftharpoons .

- (b) Since the question was designed to focus candidates' responses specifically on equations, observations and explanations, it was not necessary to include a detailed account of a 'fair tested' practical procedure. The inclusion of this was clearly not penalised in any way. It was however noticeable that even high scoring candidates did not always address exactly what the question demanded. Few candidates therefore mentioned that the magnesium would disappear during the reaction and even fewer explained the difference in rate of reaction in terms of the difference in concentration of H^+ ions. Although the question was written so that a weak acid, apart from propanoic acid, could be used, most candidates gave an equation using this example. It was encouraging to note how many correct equations were seen.
- (c) The inclusion of an ionic equation is often a feature of this unit and therefore it was perhaps surprising how few completely correct responses were seen. Many candidates correctly gave the products of the reaction, as being carbon dioxide and water, but few gained the second marking point. Many candidates gave the formula of the carbonate ion with one negative charge but a large number gave equations that were not based on ions at all. Large numbers showed $NaCO_3$ or $NaCl_2$.

2813/02: Experimental Skills 1 Coursework

General Comments

The number of centres submitting work for the Coursework option was close to two-thirds of the total entry at AS and three-quarters at A2. There were several centres entering for the first time this year and they are to be congratulated on the care with which they approached this rather daunting task. On the whole the quality of administration of centres is very good and it is to the credit of so many that work is carefully assembled and reliably annotated. The importance of this in supporting the reliability of the moderation cannot be underestimated especially as the Moderators are usually prepared to give the benefit of the doubt to candidates on borderline issues if the basis of the centre's judgement can be clearly seen. Less satisfactory was the adherence to the Board's deadlines and an unacceptably high proportion of the work and/or mark sheets arrived well past the deadline of 15 May. It is hard to be sympathetic to this when it is a well-publicised date which does not change each year.

Understandably those candidates who have progressed to A2 tend to perform rather better as a group than those at AS and the proportion achieving grade a is relatively high. A regular concern of the Moderators is that the level of support given to candidates varies between centres and so it must be emphasised that it is considered to be the best practice to ask students to complete skills I, A and E in the laboratory under supervision. Although this is not mandatory it is otherwise very difficult to see how a centre can vouch that the final submission is a candidate's own unaided work. Centres are also reminded that teachers are not permitted to receive an initial draft and give advice on ways it might be improved prior to a final version.

An issue that has become of increasing concern and which affected a wide range of candidates is the increasing number of calculations for skill A that have resulted in an incorrect answer because numbers have been truncated to a small number of significant figures during the course of the processing. There appears to be a misunderstanding over what is expected with regard to significant figures. Candidates should only be penalised if their final answer is quoted to an unacceptable accuracy. During the course of the calculation, candidates should retain all the decimal places generated. It is, of course, acceptable (and possibly more correct) to quote intermediate answers to an appropriate accuracy but candidates should maintain the full number to proceed to the next step required. This was particularly noticeable in the determination of the relative atomic mass of lithium where candidates incorrectly gave the answer to two decimal places having rounded numbers earlier in the calculation. Centres are also reminded that, when using this experiment to assess skill I, it is inappropriate to quote the volume of gas measured in a 250 cm³ measuring cylinder to anything more precise than a whole number.

Comments on Individual Skills

Planning exercises were usually marked according to the criteria but there are a few points to note. References must be according to the instructions given to the candidates, which is to quote, at the minimum, a chapter when referring to a book or a web address that goes beyond the first 'slash'. The failure to use sub- or super-scripts correctly must also be penalised under P7a although a very occasional slip should be accepted. The decision over an appropriate dilution of hydrochloric acid in the limewater determination must be preceded by a calculation which explains why this is necessary. Some candidates merely stated what they were going to do without justification and therefore failed to achieve P5a.

The 'a' strands of skill I are usually left to the centre to judge but it is helpful if any judgement made is accompanied by some justification, for example by using a tick list.

It is hoped that centres will encourage their students to make a full risk assessment when performing an experiment but they may be allowed that strand of I7a if at least two relevant comments have been made.

Evaluation is a demanding skill and for many it was their lowest mark. It must be emphasised that improvements do not refer to the correction of personal incompetence when doing the experiment but to correcting inherent faults present in the procedure or the measurements made. A common suggestion for the improvement of the procedure used in the measurement of the relative atomic mass of lithium was to use a syringe instead of a measuring cylinder to collect the volume of hydrogen. This is not considered to be worthy of credit as it does not address the real problem which is the loss of hydrogen as the lithium is added to the conical flask. It is also unlikely that any greater accuracy would be achieved in this way and certainly not if the mass of lithium had to be reduced to match the capacity of a 100 cm³ syringe.

2813/03: Experimental Skills 1 Practical Examination

General Comments

The number of candidates entered for this option continues to increase. Generally candidates seemed to be well prepared for the examination, and the quality of most Plans was very pleasing. Most candidates found the evaluation difficult, despite the fact that they had more time to consider their answers than on most other papers.

Some comments were received from centres on the choice of indicator used in the titration. The reason for using bromothymol blue was to introduce variety, instead of using phenolphthalein yet again. The colour change for bromothymol blue is at one extreme of the end point pH change range for a weak acid–strong alkali titration. This is why candidates were instructed to look for the green → blue colour change (rather than the yellow → green that would have been suitable for a strong acid–strong alkali titration). Most centres reported no difficulty with the green → blue colour change, but it may be that impurity in the indicator may have caused problems for some centres.

Comments on Individual Questions

PLAN The quality of the Planning Exercise (identifying the ‘unknown’ organic liquids) was higher than usual, with many candidates achieving marks in the double figures. A range of interesting alternative approaches were suggested. Although the majority of candidates chose to eliminate the substances one by one using specific tests, some chose to separate the ‘OH’ compounds first, using either sodium or phosphorus pentachloride, and then carry out the sequence. The mark scheme allowed for all such approaches to score full marks, provided that the tests selected were unambiguous in their context. The nature of the exercise enabled most candidates to present their answers in a logical and ordered fashion. A few candidates introduced excessive irrelevant material, such as mechanisms or details of manufacture or use of the materials, which was penalised. Some candidates did not draw a genuine flow chart but, instead, presented what was just a list of tests.

The basic facts of most chemical tests were described well. Discrimination resulted from the level of appropriate detail included in the answers. Necessary conditions for reactions were required, and candidates were always expected to state the result that was observed in the test (e.g. not just ‘hydrogen produced’). Different types of organic formulae were accepted in equations, provided that the functional group was shown: however C_6H_{10} was accepted for cyclohexene.

One common error was that of describing silver bromide as a ‘white’ precipitate. If esterification was described as a test for either alcohol, the name of the ester formed was required. Descriptions of the Lucas test did not always specify the link between the type of alcohol (tertiary) and the fast rate of the reaction. Many candidates identified the tertiary alcohol by elimination, having given positive tests for the other five. However the question clearly stated that six positive tests were required.

As usual, the quality of written communication of most candidates was very good, but it remains disappointing that a significant minority fail to show the word count.

TEST

Part 1 The use of bromothymol blue indicator was new to many candidates. The mark scheme allowed a somewhat greater tolerance than normal when awarding marks for accuracy. Once again, centres are reminded that good, reliable results from Supervisors are essential if their own students are not to be disadvantaged when the accuracy of their results is assessed. In this examination, there were more examples than normal of Supervisor's results that were either poor or not submitted at all. Most candidates appeared to have no difficulty with the green \rightarrow blue end point colour change. About half of all candidates scored full marks for accuracy, but there was a significant minority who scored 0 out of 7 for this part of the exercise.

Candidates should be taught to record all weighings and all burette readings. Those who record only the differences lose marks. The trial reading should also be indicated, and all burette readings should be recorded to 0.05 cm^3 .

Part 2 As usual, the calculation discriminated effectively between candidates. Better candidates had no difficulty with the numerical section and an answer of about 93% for the purity was typical. It was disappointing that the instruction to give state symbols in the titration equation was often ignored. Candidates should always be encouraged to keep going through the structured calculation, because marking is always done on an 'error carried forward' basis. Many candidates do not understand the concept of three significant figures, confusing it with three decimal places.

The answers to the final question (h) were disappointing. Relatively few candidates grasped the idea that, if the impurity reacted with either of the titrant solutions, it would affect the calculated % purity. The question indicated that the impurity in the acid came from the atmosphere, but many candidates had interesting theories as to what the Earth's atmosphere contains.

Part 3 The Evaluation section proved to be very demanding for many students. In (a) the link between the reliability of results and consistent, repeated readings is one about which many candidates are unsure. Question (b) was done better, but many students did not explicitly refer to a 1 : 1 mole reacting ratio between ethanoic acid and sodium hydrogencarbonate, which is an essential step when deducing whether reacting quantities are suitable.

Question (c) was disappointing. Too many students focussed on distractors in the information presented: 'Measure exactly 10 cm^3 of water', or, 'Time for exactly one minute' were common suggestions. Many candidates identified leaks in the apparatus as a problem, which would only happen if experimental technique was particularly poor. Among ideas that could have scored full marks were:

- the very small masses of solids used
- the escape of gas before the bung could be placed on the flask (so use an 'inner test-tube' to contain one of the reagents)
- the unsuitability of a 250 cm^3 measuring cylinder for collecting the gas
- the need to speed up the reaction and to measure the final volume of gas only when the reaction was complete
- the solubility of carbon dioxide in water and in the acid

2814: Chains, Rings and Spectroscopy

General Comments

The paper produced a good range of marks with many centres clearly preparing their candidates very well. A pleasing number of candidates were able to demonstrate a thorough knowledge and understanding of the ideas covered in the specification. Teachers had obviously made good use of the published mark schemes of previous papers to help their candidates prepare. It is also good to see that candidates now seem to be more familiar with some of the material added to the specification from January 2006 onwards. There were relatively few very poor scripts, although a few clearly do find the subject very demanding at this level. Most candidates appeared to finish the paper in the time allowed. A small number however missed out the final part to Question 7 on the back page. Candidates should be reminded always to check carefully that there are no further questions, before deciding that they have finished the paper.

Comments on Individual Questions

- 1)
 - (a) Most candidates recognised that compound **A** had amino and carboxylic acid groups. However many were unable to explain that it didn't fit the general formula for an α -amino acid because these two groups were not attached to the same carbon.
 - (b) Many candidates completed the equation correctly and recognised this as an electrophilic substitution reaction. A good number also knew that either iron(III) chloride or aluminium chloride would be a suitable catalyst for this Friedel–Crafts reaction.
 - (c) The unfamiliar amino acid did not prevent the more able candidates drawing the correctly ionised forms in neutral and acidic conditions.
 - (d) Most candidates were also able to combine compound **B** with compound **A** with a peptide bond linking the correct groups. A number of candidates linked the two compounds with an acid anhydride link, which was also credited.

- 2)
 - (a) Most candidates knew the reagents needed for bromination, neutralisation and nitration of phenol. Credit was not given if a halogen carrier was included with the bromine, as the specification requires candidates to be aware that phenol reacts readily with bromine without needing a catalyst. However, candidates were not penalised for including concentrated sulphuric acid with the nitric acid, as they are not expected to know exactly how the nitration reaction is affected by the presence of the OH group. The practical details of how to prepare an azo dye were well known by the better prepared candidates. The most common omission was to forget the alkaline conditions needed to couple the diazonium ion to the phenol.

- (b) This question was well-answered by many candidates, who could accurately describe the overlap of p-orbitals above and below the ring to form the delocalised π -bonds in benzene. A few weaker candidates do still seem to get confused between p-orbitals and π -bonds. For full credit some further detail of the bonding in benzene was also needed. This could have been the equivalence of the C–C bond lengths/strengths or identifying that σ -bonds form the other covalent bonds in the molecule. Many also went on to describe correctly the delocalisation of the lone pair from the oxygen atom to increase the π -electron density around the benzene ring. They did also need to state clearly how this would increase the susceptibility to electrophiles by polarising them more easily or by increasing the electrostatic attraction between the ring and the electrophile.

3)

- (a) The polymerisation reaction to produce nylon-6,6 from the acid chloride was well known, with most candidates able to draw a correct repeat of the polymer. A few gave water, rather than HCl, as the other product. However, candidates do now seem to be more aware of reactions involving acid chlorides than last year, when these were new to the specification.
- (b) Most candidates could deduce the structures of the monomers that could be used to form the given polymer, although a common error was to draw 1,4-substituted benzene rings instead of the 1,3-substituted rings needed in this case. For the last part, any sensible suggestion that could explain greater intermolecular forces between the polymer chains was accepted.

4)

- (a) There were a good number of correct answers to this part, but a significant number of candidates did not read the question carefully and drew displayed, rather than skeletal formulae for the *cis* and *trans* isomers of but-2-enal.
- (b) Nearly all candidates knew that Tollens' Reagent could identify the aldehyde group, but many forgot to mention that this must be warmed to produce the silver mirror. Also a fair number did not include enough detail in their explanation for why the aldehyde gives this result. The specification does require knowledge of the details of the redox reaction involved.
- (c) This was well-answered, with many candidates correctly describing the reduction of the aldehyde to a primary alcohol, leaving the C=C double bond unchanged. Some candidates attempted to name the compound, rather than draw its structure. This was more difficult, and the best advice in such situations is to draw the structure in an unambiguous form, rather than risk making an error with a complicated name.
- (d) The equation for the complete combustion of the but-2-enal to give carbon dioxide and water was well done, with just a few candidates making errors in balancing the oxygen atoms.

- (e) A pleasing number of candidates were able to draw a correct structure for the addition polymer from this unfamiliar alkene. Most also knew that 'atactic' meant that the side-chains were somehow randomly arranged along the chain. However a fair number of answers did not make it clear that it is the 3-D orientation that is random. On this occasion, candidates were given the benefit of the doubt, but teachers should be aware that that in a longer question with more marks available a more precise description would be needed for full credit.

5)

- (a) Most candidates sitting this paper seem to be confident at interpreting infrared spectra. As long as they quoted the correct wavenumber range from the Data Sheet or the exact position of the absorption on the spectrum as well as the relevant bond causing it, they scored full credit. A few did however fail to be awarded the mark for the alcohol absorption at $3230\text{--}3550\text{ cm}^{-1}$ by describing the bond as C–OH. It must be clear that the absorption is caused by the O–H bond.
- (b) This less-familiar example of nucleophilic addition proved to be a good opportunity to give credit to candidates who understood the principles behind this mechanism. In particular, some struggled because they were unclear when a full negative charge should be shown and when it is just a partial charge (δ^-). Relatively few candidates scored the fifth mark by showing how the intermediate reacts with a molecule of water, even though this reaction is the addition of a water molecule. However, some credit was given to any who showed the intermediate donating a pair of electrons to a proton.
- (c) The calculation proved to be fairly challenging for candidates, as they had to take into account that 21 doses of 0.250 g would be needed in a week and also that they needed to allow for the 60% yield. However, many still scored some marks, as credit was given for errors carried forward. Any answer rounding to 7.8 g was accepted.
- (d) The equation for the oxidation of chloral hydrate to trichloroethanoic acid and water was correctly deduced by a good number of candidates, although a few made errors in balancing the number of oxygen atoms.

6)

- (a) Most candidates were not put off by the large structures in this question and this part was generally well-answered. Deducing the number of carbon atoms in the skeletal structure of cypermethrin (22) proved to be the most challenging part. A common error was 21 – presumably missing out the carbon in the nitrile group.

- (b) Nearly all candidates knew that the lower doses needed for the product made by the enzyme was somehow due to optical isomers. However, many did not score full marks, as they did not explain that the synthesis had created a chiral centre, so that the laboratory method would give a 50/50 mixture of optical isomers, compared to the stereospecific enzyme-catalysed reaction. They also needed to state clearly that only one of the optical isomers would be active as the insecticide. Vague statements, such as 'one isomer is useful', were not credited. Also a number of candidates did not put their answers into the context of this question and wrote answers describing drugs and problems of harmful side-effects, which were not relevant to this situation.
- (c) For acid hydrolysis of the ester group, heating under reflux with a suitable named aqueous acid was required for full credit. In the second part, many candidates successfully drew the two molecules formed by hydrolysis of the ester group. However, very few also spotted that the nitrile group would be hydrolysed to a carboxylic acid.

7)

- (a) Most candidates could interpret the structural formula of the ester given, although some did lose a mark by not displaying the CH_3 groups. If a displayed formula is asked for, then all the bonds should be shown.
- (b) Describing the reagents, conditions and an equation for the formation of the ester proved to be a good opportunity for candidates who knew their chemistry well to score high marks. Naming the methylpropan-1-ol incorrectly was the most common error. To produce a reasonable yield of an ester from a carboxylic acid and an alcohol the acid catalyst must be a non-aqueous dehydrating acid, such as concentrated sulphuric acid. Candidates should be made aware of the difference in conditions needed for the formation and hydrolysis of esters.
- (c) Most candidates knew that mass spectrometry could be used to obtain the molecular mass of the ester and as long as they clearly described where to find the molecular ion peak, they achieved full credit.
- (d) This part required a thorough knowledge of all the different ways that an n.m.r spectrum can give information about the arrangement of protons in a molecule. To achieve high marks, candidates could include suitable examples to illustrate each point and also explain that the peak areas give the ratio of the numbers of protons in each environment, not necessarily the actual number. Some candidates seemed to think incorrectly that peak heights, rather than areas, were related to the numbers of protons. However, there were many well described examples of peak splitting. Credit was also given for a description of how D_2O can be used to identify the presence of OH groups in a molecule. The final example in part (ii) was well done, even by some candidates who could not put into words how to interpret an n.m.r. spectrum in the previous part.

2815/01: Trends and Patterns

General Comments

The average mark for the paper was 24.8 which was very similar to the corresponding mean mark in the June 2006 paper. The whole mark range was covered from 0 to 45. There was very little evidence that candidates ran out of time and only a small proportion of candidates left much of their examination paper blank.

The specification grid for this examination paper indicates that about 30 marks are allocated to synoptic ideas. There was evidence from the candidates' answers that they found the synoptic aspects of the examination much more demanding than those questions based on the content from the Trends and Patterns part of the specification.

Many candidates did not use chemical terminology with precision. There was some improvement over previous examination papers over the use of the terms atoms, ions, molecules, compounds and elements.

Candidates found the long question on types of answers were demanding and often including lots of irrelevant material instead of focussing on the three reaction types in the question. There was very little evidence that candidates planned their answer to question 5 and often candidates just wrote about oxides and chlorides of elements in Period 3.

Comments on Individual Questions

- 1) This synoptic question required candidates to link knowledge and understanding from Trends and Patterns and Foundation Chemistry.
 - (a) The correct equation and state symbols were both needed for one mark. Common misconceptions included the use of Al_2 and that the aluminium chloride was formed in aqueous solution.
 - (b) Candidates needed to be able to identify the bonds or forces that needed to be overcome as well as the relative strength of the force or bond. Ionic bonding, giant ionic or electrostatic attraction between ions for magnesium chloride and van der Waals' forces for silicon(IV) chloride were given credit. A further marking point was given for a comparison of the strength of the bonds or forces. Good answers referred to strong attraction between ions and weak van der Waals' forces between molecules of silicon(IV) chloride.

Common misconceptions included magnesium chloride having strong intermolecular forces or having a giant structure with molecules. Another misconception was that covalent bonds were weaker than ionic bonds although this was seen somewhat less than in previous examination papers.
 - (c) Candidates were likely to be awarded a mark for referring to moving ions in magnesium chloride. A smaller proportion of candidates were able to explain that there were no free electrons in silicon(IV) chloride. It was not sufficient to just state that there were no ions in silicon(IV) chloride. A common misconception was to refer to free electrons in molten magnesium chloride.

- 2) Candidates found this question about iron(III) one of the more accessible questions on the examination paper.
- (a) Only a small proportion of the candidates could not give the electronic configuration for an iron(III) ion and an even smaller proportion could not explain why iron is a transition element.
- (b) Even though cyano complexes are not covered by the specification, a large proportion of candidates could suggest why the cyanide ion could act as a ligand. To gain credit candidates had to mention the presence of a lone pair and that it could be donated. No penalty was incurred by candidates referring to the lone pair on nitrogen being donated.
- A very large proportion of candidates could draw a three-dimensional representation of an octahedral shape but a smaller proportion could state the correct bond angle. To gain full marks candidates had to also state the name of the shape as indicated in the question.
- (c) In (i), the majority of candidates recognised ligand substitution. Ligand exchange or ligand displacement were also accepted in the mark scheme but nucleophilic substitution was not.
- The blood red colour of the $[\text{Fe}(\text{H}_2\text{O})_5(\text{SCN})]^{2+}(\text{aq})$ complex ion was well known by candidates.
- (d) In (i), many candidates gave the correct colour for iron(III) hydroxide but failed to mention it was a precipitate and were not awarded a mark.
- Although a significant proportion of candidates could write the ionic equation they did not always give the correct state symbols; in particular $\text{Fe}(\text{OH})_3(\text{aq})$ was very common. Only a very small proportion of the candidates wrote molecular equations but a greater proportion of candidates included the spectator ions.
- 3) Candidates of all abilities were able to draw a recognisable Born–Haber cycle but frequently candidates found parts (a) and (c) very demanding.
- (a) The majority of candidates were unable to explain the direction of energy transfer in first ionisation energy and the first electron affinity. It was not sufficient to state that first ionisation energy required energy and first electron affinity released energy. To gain credit candidates had to refer to the attraction between electrons and the nucleus as well as electron loss in part (i) and electron gain (ii). There was evidence that a significant proportion of candidates did not read the question sufficiently well and answered about first and second ionisation energy.

(b) The majority of candidates drew energy level diagrams but other correct cycles were given full credit. The most common errors were the

- use of the wrong formulae e.g. $O^+(g)$
- wrong stoichiometry e.g. $Ca(s) + O_2(g)$ rather than $Ca(s) + \frac{1}{2}O_2(g)$,
- wrong labelling of energy changes

The correct value for the enthalpy of formation was -635 kJ mol^{-1} . The unit was required for full credit. An error carried forward mark was allowed from incorrect cycles.

In part (iii) only a small proportion of candidates realised that Fe^{2+} must have a smaller ionic radius than Ca^{2+} . Credit was not given to references to the wrong type of particle for example Fe has a smaller atomic radius.

4) This question focussed on the ferrate(VI) ion and involved synoptic assessment of topics such as redox and calculations.

(a) The majority of candidates were able to construct a redox equation. One mark was given for equations that still included electrons or contained the correct reactants and products but were not balanced.

(b) Candidates of all ability were able to make progress and this question was rarely left blank. Good answers were well laid out and it was very easy to follow the steps involved. Candidates had to quote the answer to three significant figures to get full marks and full credit was given to either 21.6. or 21.7.

Common misconceptions included the wrong formula to calculate the relative formula masses e.g. using FeO_4^{2-} instead of Na_2FeO_4 . Other candidates used the relative atomic mass of iron instead of the relative formula mass of iron(III) oxide. A significant proportion of candidates did not take into account the molar ratio of 2 : 1 ($Na_2FeO_4 : Fe_2O_3$).

(c) A large proportion of candidates scored at least one mark for calculating the oxidation numbers. The most common misconception was that the oxidation number of oxygen changed from -8 to 0.

(d) In part (i), the mark scheme required that the species responsible for the observation was also noted down. Although a significant proportion referred to a brown colour being produced often a reference to iodine was not made.

Although a significant proportion of candidates gave correct answers to part (d) (ii), including oxides of nitrogen, elemental nitrogen and hydroxylamine others gave answers such as NH_2^- , NH_3O or NH_4^+ .

5 Many candidates found this question extremely demanding and a significant proportion scored no more than three marks including the mark for Quality of Written Communication.

The mark scheme required a simple definition, an equation for an example and an observation from the reaction however many candidates simply listed as much chemistry from Period 3 as possible without really trying to answer the question. There was a significant amount of 'made-up' chemistry with exotic reactants and products. A significant number of candidates also gave two or three examples of each type of reaction but far too often many of the examples were wrong and so could not be awarded a mark since the mark scheme precluded Examiners from choosing a correct example among a collection of wrong examples.

Candidates had to define acid–base reactions in terms of proton transfer and credit was not given for a reaction in which an acid is neutralised by a base. The most common correct examples were

- sodium hydroxide and hydrochloric acid
- magnesium oxide and hydrochloric acid.

The mark scheme for hydrolysis only needed a reaction with water but this mark was not given if the example gave an acid–base or a reaction with an element. The most common correct examples were

- silicon(IV) chloride and water
- phosphorus(V) chloride and water

Candidates generally gave correct observations for these two reactions. A small proportion of the candidates chose examples from organic chemistry.

Common misconceptions for hydrolysis include the reaction of sodium with water and the reaction of basic oxides or acidic oxides with water.

The mark scheme for the definition for thermal decomposition did not require a mention of heat; it only needed to refer to the breakdown of a compound. By far the most common example was the decomposition of magnesium carbonate with correct observations referring to a white solid being formed and a colourless gas being evolved.

Common misconceptions included decomposing oxides into the element and oxygen.

The majority of candidates were awarded the mark for Quality of Written Communication which required correct spelling and grammar in at least two sentences.

2815/02: Biochemistry

General Comments

This paper proved accessible at all levels of ability. There were fewer marks than usual below 10, but the majority of candidates scored 30 or more. There were some excellent scripts at the top end showing sound knowledge coupled with an ability to apply this to unfamiliar compounds. On the other hand some common mistakes showed a clear lack of such understanding at the lower end, for example pentavalent carbon atoms, hydrogen bonds to C–H, a polydeoxyribose backbone for DNA. Several candidates seemed neither to be able to read the questions accurately nor to express answers clearly enough to gain the marks.

Comments on Individual Questions

- 1)
 - (a)
 - (i) The glycosidic link was correctly indicated by most.
 - (ii) Many candidates correctly identified the configuration as α , but half of them went on to write 1–4 α having misread the right-hand ring. This is simply an α -D glucose rotated by 180°.
 - (b)
 - (i) More candidates chose enzyme over acid hydrolysis.
 - (ii) Glucose was the universal and correct response.
 - (c) Most candidates were able to draw two different hydrogen bonds between water and trehalose. Some lost a mark by twice using H attached to O on the disaccharide. About a quarter of the entry tried to make hydrogen bonds to C–H.

Candidates were not penalised for making two hydrogen bonds from one H₂O molecule to the same OH group; this is highly unlikely because of the resulting 90° bond angles required.
 - (d) Most candidates correctly referred to the lack of branching in the polymer from trehalose.
- 2)
 - (a)
 - (i) Most candidates correctly drew at least one ester group and there were fewer missing hydrogen atoms on glycerol on this occasion. Those who tried to draw out the whole of the linoleate structure, either displayed or skeletal, often omitted the double bonds altogether. Candidates were not expected to know the position of the double bonds.
 - (ii) Many good candidates made the necessary calculations, but gave their answer for one linoleate residue rather than for the whole triglyceride as asked.

- (b) Candidates from some centres were well prepared for this type of question. They discussed the role of van der Waals' forces in making a solution in a non-polar solvent such as hexane. They were then able to explain that there were too few possibilities for hydrogen bonding for solubility in water. On the other hand, too many attempted to answer the question in vague terms such as 'like dissolves like' with no reference to the intermolecular forces involved.
- (c) (i) Most candidates earned the marks for the replacement of one fatty acid group by phosphate. The common mistakes were to omit any mention of fatty acid or to refer to it as a hydrocarbon. 'Phospho' was not accepted for phosphate.
- (ii) The actual drawing proved easy enough. A few drew micelles or had one or three tails instead of two. A number failed to use the term hydrocarbon chains as asked.
- 3) (a) (i) Although this type of question is frequently asked, many candidates got in a muddle, perhaps starting with an aldehyde group CHO at one end. Valency rules were ignored by the weakest.
- (ii) Only a minority of candidates correctly wrote 'ester'. The most common incorrect alternative was aldehyde, even when there was no aldehyde group in their answer to part (i).
- (iii) Few candidates answered this in the context of the Clinistix, instead choosing an advantage from a 'remembered list' which was not relevant in this case.
- (iv) Successful answers focussed on the active site and the ideas of fit and shape. A substrate is not the same shape as the active site; it has a complementary shape. Weaker answers simply repeated the specificity idea given in the question.
- (b) (i) Nearly everyone correctly plucked the structure of cysteine from the diagram, but only half drew the structure as a zwitterion, which it would be at pH 7.
- (ii) This was an easy mark for most, although several candidates wrote lipase or just referred to stains generally.
- 4) This question was a good source of marks for all candidates, although success with part (c) was very centre specific.
- (a) Nearly all gained two marks for the types of interaction, apart from the few who described hydrogen bonding in spite of the sentence immediately above. Most gave correct diagrams showing how their chosen types of interaction worked. Here weaker candidates made mistakes with S-S bonds shown as dotted lines, and ionic bonds involving Na^+ and Cl^- .

- (b) Quaternary was the usual answer, though not the usual spelling – quarterary was the most recognisable incorrect version. It still got the mark.
- (c) Well prepared candidates had no problem with this question, largely because they were able to start with NH_3^+ and COOH groups. The idea of deprotonation of the NH_3^+ group leading to a loss of ionic attraction then follows easily. Many others started by deprotonating COOH which then left the rest of the argument almost impossible. Some reference to the disruption of the tertiary structure was required.
- (d) (i) The great majority of candidates drew an appropriate curve, though some skated close to V_{max} .
(ii) All but the weakest remembered the theory behind non-competitive inhibition and scored both marks.
- 5) Candidates who concentrated on the chemical rather than biological ideas did well here although there was considerable centre dependency.
- (a) There were some excellent drawings of structures to show how the polymer is put together, with correct positioning of the base and the ester groups on the deoxyribose ring and a mention of the loss of water in condensation as the phosphate ester groups are formed. It was not necessary to write full structures of bases to gain full marks.
Many poor answers started with glycosidic links between deoxyribose molecules and left the bases out altogether. Other unsuccessful approaches used skeletal cyclopentane representations for the deoxyribose molecules. This left any numbering ambiguous and the C5 sidechain invisible. Even with poor answers however, the Quality of Written Communication mark could be awarded for two sentences that were reasonably free of errors.
- (b) Most candidates chose the difference in monosaccharide, but a significant number discussed the difference in bases in spite of the question. Others did not understand the meaning of the words ‘chemical composition’ and wrote about the relative sizes or number of strands in the two polymers.
- (c) (i) The commonest answer, even from otherwise good candidates, was to draw three hydrogen bonds between the bases, which meant using the C–H hydrogen for the bottom bond. Candidates were not expected to know which bases these were, but they were expected to analyse the structures.
(ii) The best candidates described the value of having relatively weak hydrogen bonding in the double helix which allows it to be unzipped easily. They also recognised the importance of the number of hydrogen bonds between the base pairs in ensuring the accuracy of transcription. But there were many vague statements about complementary base pairing, which ignored hydrogen bonding altogether. Some candidates wrote all they knew about translation in biological terms which usually failed to score.

2815/03: Environmental Chemistry

General Comments

A full range of marks was seen from the small entry, and scores in general were higher than last year. Only the best candidates were able to show competence in all sections of the specification. There was still a tail of candidates who seemed to be quite unprepared for this A2 option. The chemistry of clays was better known this year, but hardness of water again proved difficult for many. Most candidates were most comfortable with descriptive material, but least with equations. There is still a common tendency to attempt to balance equations by changing the formulae. Most candidates scored the Quality of Written Communication mark for spelling, punctuation and grammar, but too many went on to lose marks elsewhere because of a lack of dexterity with technical language.

Comments on Individual Questions

- 1) This proved to be the easiest question on the paper.
 - (a) Most candidates earned the mark with a comment about packaging in general or poly-bags in particular.
 - (b)
 - (i) Most were able to find three of the four organic options available. A few included metals, glass or others in their lists.
 - (ii) Simple statements about reducing the bulk of waste for landfill, and using the energy released to provide local heating or electricity were required. Several answers were too vague, and a few candidates suggested methane would be produced in an incinerator.
 - (iii) Most candidates knew about the toxic nature of dioxins and about the need to avoid the relatively low temperatures at which they form. One gave the correct structure of a dioxin, which was not required.
 - (c)
 - (i) Nearly all candidates scored the mark for respiration, except those who wrote 'breathing' instead.
 - (ii) A comment on the need for oxygen to allow aerobic decay of organic waste by micro-organisms (bacteria) was required, and a variety of answers in this vein were accepted. There was some confusion with the use of ozone in water treatment to kill bacteria.

- 2) (a) (i) Incomplete combustion of a hydrocarbon fuel was required for CO, and several candidates wrote correct equations for suitable alkanes. Combustion of methane, carbon or fuels generally did not score. For NO either a comment about direct combination at high temperatures or a balanced equation was required.
- (ii) The majority of candidates drew a correct '*dot-and-cross*' diagram. The commonest cause of error was to start with only a single bond between the N and the O.
- (b) (i) The great majority knew where the stratosphere is found, most giving acceptable height ranges. A few suggested unsuccessfully that it was where ozone was found.
- (ii) Absorption of UV radiation, rather than IR, and reducing effects such as skin cancer were well known. 'Damaging radiation' was not enough.
- (iii) Most candidates were able to write the two equations for the oxygen only model for the production of ozone in the stratosphere. Several forgot to mention the role of UV radiation in starting the process.
- (iv) The reaction of NO with ozone was usually answered correctly in words or with an equation. The oxidation of NO to NO₂ frequently included an oxygen atom as a product; presumably this being added in an attempt to balance the equation.
- (c) (i) This proved to be the hardest question on the paper with most candidates scoring 2 marks or less. The problem was a lack of familiarity with the photolysis of NO₂ in the troposphere, which produces NO and an oxygen atom. This leads to the formation of ozone. Subsequent reactions involving radicals produce photochemical smog. Most candidates scored their marks by mentioning a couple of relevant radicals and the role of UV radiation.
- (ii) Some candidates were successful in quoting the correct equation (residence time = concentration/rate of removal). Others wrote that it represented the average time a species remained in the atmosphere. The commonest mistake was to leave out the word average.
- 3) Generally speaking a greater proportion of candidates knew some clay chemistry than in previous years.
- (a) Solid shapes or structures showing links between atoms were equally acceptable. The octahedral arrangements proved to be the more difficult to draw.
- Most knew about the silicate–aluminate–silicate sandwich.

- (b) The majority of candidates knew how hydrogen bonding between the layers of 1 : 1 clays prevents the entry of water. A minority knew which atoms were involved. Similarly candidates knew why 2 : 1 clays absorb water and expand, but very few mentioned the hydrogen bonding of some of that water to silicate oxygens. The Quality of Written Communication mark was awarded for accuracy in spelling, punctuation and grammar.
- (c) The last part proved more difficult. The commonest error was to confuse the expected process of ion exchange with the substitution of Al for Si in the structures of the original clays. The best answers gave an equation for the ion exchange and used this to discuss the effects of lowering the concentration of potassium ions in the soil water. Le Chatelier's principle was useful but not essential for full marks.
- 4) Part (a) was usually well done, but many candidates failed to make much of the rest of the question.
- (a) High pressure and low temperature at depth were correctly suggested by nearly all.
The commonest response was to quote the equation
- $$\text{H}_2\text{O} + \text{CO}_2 \longrightarrow \text{HCO}_3^- + \text{H}^+$$
- This scored both marks only if state symbols were used showing that the carbon dioxide was aqueous. Otherwise the name or formula of carbonic acid was expected, together with an equation for its first ionisation.
- (b) (i) Candidates from some centres produced excellent answers based on the formation of calcium hydrogencarbonate solution, frequently with an equation. Otherwise incorrect responses led too frequently to solutions of calcium carbonate or, worse, calcium alone.
- (ii) Those who knew what temporary hard water actually is were easily able to reverse their answer to part (i). The best answers mentioned the insolubility of calcium carbonate using ideas of thermal decomposition or the shift of equilibrium as carbon dioxide comes out of solution. Some unsuccessfully tried ion exchange or the use of sodium carbonate. The weakest candidates left this part blank.
- (c) Better answers progressed neatly from SO_2 through SO_3 to H_2SO_4 . The H_2SO_3 route was equally acceptable. These answers contained one or two correct equations in addition to that showing the dissociation of sulphuric acid. At the other end of the spectrum there was much invented chemistry, sometimes giving hydrogen gas as a product, perhaps to help with equation balancing.

2815/04: Methods of Analysis and Detection

General Comments

It is pleasing to see a large proportion of candidates entered for this module having a good grasp of this branch of chemistry. There was evidence that many candidates were thoroughly prepared and had been taught all of the specification.

Candidates do very well at using a number of types of analytical data to deduce the structure of a compound.

Candidates should be reminded that a question that appears familiar to them from a past paper may actually be asking a different question, or have a different emphasis than they might expect and that they should take care to read and answer that question before them, not one they think they have seen before.

Comments on Individual Questions

- 1) This question was accessed by the majority of candidates.
 - (a)
 - (i) The question asked for an explanation of partition and so a candidate described it as a partition did not score.
 - (ii) Candidates who failed to score full marks here often did so through lack of precision and detail in their answer. For example the stationary phase needed to be described as the solvent or oil or hydrocarbon on the solid support or tube, etc.
 - (b)
 - (i) Many candidates scored full marks for the labels on the chromatogram but, if a label is asked for, it is not enough just to put a ring around a spot: a label is necessary.
 - (ii) This was correctly answered by a small number of candidates, since most failed to appreciate that the 5th is a mixture of two amino acids.
 - (c) This was very well answered by the majority of candidates.
 - (d) Care was needed with language in this part. Many candidates scored well but a significant number lost marks by being imprecise. For example, when explaining why pH control is important candidates often stated that pH affected the amino acid, but did not state what this effect was.
- 2) A number of candidates failed to recognise the significance of bromine isotopes in mass spectra. They used and quoted an M_r of 79.9 from the *Data Sheet* and seemed completely unaware how this number is derived. Those who did this often only scored marks in part (c).

- (a); A significant number of candidates did recognise the fragments and the bromine isotopes present in them. Candidates must remember to include a charge, since
- (d) these fragments are ions. Some candidates also only put the atomic mass with one of the bromine atoms and this lack of detail and precision cost marks to some good candidates.
- (b) This question was well answered by many candidates.
- (c) Many candidates quoted and used the correct equation to perform this calculation. Errors occurred by candidates not recognising that there are two carbon atoms. Candidates should also be reminded of the use of significant figures, taking their lead from the number of significant figures in the question.
- 3) This question was well answered by many candidates. A pleasing proportion of candidates showed a good level of understanding of the principles involved. For example, it is really important that candidates use appropriate language when referring to absorption of light.
- (a) (i); (ii) Many candidates scored full marks. Those that did not described the movement of electrons in the wrong direction or in no direction at all.
- (iii) This answer needed to be about the energy levels getting closer and **not** what happened to the electron (i.e. ionisation which a significant proportion of candidates referred to).
- (iv) This calculation was correctly performed by many candidates. Errors occurred from those who did not convert their answer to nm and also by candidates who were not confident, or indeed overconfident, mathematically. Significant numbers of candidates combined the two appropriate equations into one sum, an excellent approach to the question when done correctly, but doing so incorrectly and with no intermediate steps often lost all of the marks.
- (b) Many students recognised the significance of the conjugation/ chromophores / delocalisation in carotene. However, many candidates described the effect of this conjugation as 'moving it into the visible' or 'this is in the visible' and did not describe anywhere in their answer the absorption of visible light (by the electrons). This is an essential part of the principles of chemicals being coloured in this context and many answers gave the impression of a lack of understanding of what was going on; rather they showed a regurgitation of some learned language in response to this type of question without knowing how to apply it.
- 4) (a) Almost all candidates were able to use the infra-red spectrum to show that an ester was present. Those who did make errors thought that there was a broad peak of an OH at about 3000 cm^{-1} .

- (b) Many candidates scored 4–6 marks on this part. Candidates should show all of their deductions very clearly and make sure that they try to use each piece of information that they have been given, since there are marks available for this. For example stating that the n.m.r. data shows four different proton environments was worth a mark yet less than a third of students commented on this. Candidates would do well to remember to state the obvious.

This question did stretch even the most able candidates. The n.m.r. data was often incorrectly interpreted particularly for the chemical shift of 4.1 p.p.m. – despite stating that the compound was an ester and that the infra-red spectrum showed this, a large number of candidates then went on to assign this peak to an OH proton.

2815/05: Gases, Liquids and Solids

General Comments

Less than 50 candidates entered this paper, but those that did showed a good level of understanding of this branch of chemistry. All parts of the specification had been taught and to a high standard.

Comments on Individual Questions

- 1)
 - (a)
 - (i) The majority of candidates were awarded this mark.
 - (ii) Many candidates were able to use a mole fraction and multiply it by the vapour pressure of the pure component, but a significant number of candidates lost marks in their calculation of the mole fraction in the first place.
 - (b) These marks were very straightforward but candidates who did not score them all did so through a lack of precision and care, for example an incorrect water flow in the condenser or big gaps at the top of the column which would have prevented the system from working.
 - (c)
 - (i) This was the least well completed part of Q1. Many candidates failed to recognise the need for an explanation in terms of intermolecular forces and their relative strengths.
 - (ii) The majority of candidates did recognise this as negative deviation.
 - (d)
 - (i) Most candidates correctly identified this as the azeotrope, those that did not invariably used the term eutectic.
 - (ii) It was important to follow the instructions to show how an answer was derived. Many candidates did not do so and lost this straightforward mark. Those that did follow the instructions were more likely to get the correct number of plates.
- 2) This question was well done by many candidates.
 - (a) The principles of ideal gases were understood by the majority of candidates. Explanations need to be clearly linked to the conditions under which they apply.
 - (b)
 - (i) This was a mark achieved by almost all candidates.
 - (ii) Many candidates performed this calculation perfectly. Those who made errors did so in their use of the powers of 10, their rearranging of the equation or their failure to convert a number of moles into a relative molecular mass.

- 3) The context of this question seemed to bemuse some candidates. However, the ideas being asked are core ideas of this module.
- (a) (i) Many candidates used the information well to draw the phase diagram. Just using the provided data allowed access to half of the marks for this part. Most marks were lost when candidates failed to label the diagram, as instructed, or by forgetting to plot pure ice melting at 0 °C.
- (ii) Only the more able candidates were able to use their diagram and the new information to make a correct conclusion about the state of the mixture under these conditions.
- (b) (b) About half of the candidates were able to use the graph to read off the mass dissolved at the two temperatures and to subtract one from the other. A common mistake was for candidates to try to carry out a mole fraction calculation based on the solubility being /100 g, indicating a lack of understanding of standard presentation of solubility curves.
- 4) This question produced the greatest variety of marks.
- (a) Many candidates either described an appropriate method using a separating funnel or explained why this method worked. Only a few candidates managed to do both. The use of text highlighting in longer stemmed questions may help some candidates to remember to address all parts of such questions in the heat of an examination.
- (b) (b) (i) & (ii) This question stretched all but the most able candidates. Many did not know where to start with the calculation.
- (iii) Most candidates scored well, describing repeated distributions using smaller portions of solvent.

2815/06: Transition Elements

General Comments

This paper discriminated well and presented a full range of marks. There were some excellent centres, whose candidates showed meticulous care and preparation, but a few centres, which entered candidates with seemingly little grounding in the subject.

A majority of scripts were clearly legible. The use of diagrams, when required, was encouraging although a few candidates still do not use 3-D diagrams for showing the shapes of transition metal complexes.

Quantitative chemistry was less of a problem this session. Many candidates obtained a majority of the marks available.

There was no evidence of time being a factor in this examination with a majority of candidates attempting all the questions, even those who scored very low marks.

Comments on Individual Questions

- 1) (a) Most candidates knew of the use of TiO_2 in white paint. A few were confused by the use of titanium metal in alloys.
- (b) (i) This was mostly correct but some weaker candidates left the 4s electrons in place and removed the 3d.
(ii) Most candidates are aware of the need for an incomplete set of d-orbitals as a requirement for absorbing visible light to produce a coloured compound.
(iii) Candidates are getting better at interpreting visible spectra. There is however still some confusion regarding the graph with a number of candidates confusing absorbance and transmittance.
(iv) Most candidates realised that the solution would turn colourless or that a white solid would be produced, but far fewer related this to the fact that there were no longer any electrons present in the 3d orbitals.
- (c) The required response here was that ligands cause d-orbital splitting and that different ligands split d-orbitals by different amounts to create different energy gaps with different frequencies of visible light. Whilst many candidates discussed the energy gap, only a few related this to the ligands causing the d-orbitals to split in the first instance.
- (d) There were some very interesting formulae suggested for potassium titanate(IV). Unfortunately many of them had titanium in an oxidation state other than +4, with the most common mistake being K_2TiO_4 . Sensible formulae with titanium in an oxidation state of +4 were accepted.

- 2) (a) A majority of candidates misinterpreted the requirement of this part of the question. The common answer given was 'A' when the actual species which was the most powerful oxidising agent, VO_2^+ , was required.
- (b) (i) A majority of candidates correctly chose **B** and **D**.
(ii) A common error here was to miss off the H^+ ion for **D** and to use vanadium electrodes instead of platinum.
(iii) Standard conditions are well known.
- (c) (i) Many candidates scored 2 marks here. A few managed to reverse the equation.
(ii) This colour change was well known.
(iii) Many candidates realised that zinc would dissolve or 'disappear'. Effervescence was also allowed. 'Zinc forms zinc ions' was not allowed.
- (d) A pleasing number of candidates managed to calculate the volume of KMnO_4 required. Common mistakes included multiplying the moles of VO^{2+} by 5 instead of dividing and some candidates gave the answer in dm^3 rather than the required cm^3 . Error carried forward was used in these cases.
- 3) (a) (i) Most candidates knew this colour change.
(ii) The shapes of these complex ions were generally well known. A few candidates thought that $[\text{CoCl}_4]^{2-}$ was square planar.
- (b) (i) Some candidates failed to double up the cobalt half equation. Occasionally iodine instead of iodide appeared on the left hand side.
(ii) This question was a good discriminator. Weaker candidates simply stated that iodine had a bigger standard electrode potential without making any attempt to explain its significance.
(iii) Many candidates realised that the complex with ammonia was more stable. Explanations included 'because ammonia is a stronger ligand' and 'because ammonia forms stronger co-ordinate bonds'. Both were acceptable, as were explanations using electrode potential values.
- 4) (a) Many candidates scored both marks here but too many lost a mark by omitting to mention either the two 'lone pairs' or the coordinate bonds formed.
- (b) Good candidates had little trouble in drawing a 3D diagram with three ethanedioate ions bonded correctly and with the correct charge. Some candidates did not show the ethanedioate ions bonding via the single bonded oxygens and many did not give a correct overall charge.

- (c) Able candidates scored very highly here. They used 3-D diagrams to show both *cis-trans* and optical isomerism. They knew the properties of both and used language that easily scored the mark available for the quality of written communication.

Candidates lost marks on the definition of stereoisomerism, with a common mistake being reference to the same molecular formula rather than the same structural formula.

Most candidates now use 3-D diagrams to show stereoisomerism but a few hexagonal planar drawings were seen. Quite a number of candidates wrongly used the *trans* isomer to illustrate optical isomerism. Some candidates completely ignored the stem of the question and described stereoisomerism using different compounds. They were penalised on their diagrams but not on their description of the properties.

When describing the difference between *cis* and *trans* isomers, candidates should be encouraged to use bond angles to make their description absolutely clear e.g. the *cis* isomer has the water ligands at 90° to one another, the *trans* isomer has the water ligands at 180° to one another.

2816/01: Unifying Concepts in Chemistry

General Comments

Overall the performance of the candidates on this paper was pleasingly high. Of course there were a number of candidates, particularly those who struggle with the more mathematical aspects of the subject, who did not fare that well, but in the main the standard of the answers across a wide range of questions was very encouraging. This said, however, it is to be noted that often even very able candidates drop marks on what ought to be the less challenging aspects of the course. In particular few candidates were able to come close to the correct equation for the reaction of nitric acid with limestone. This was also evident in the questions involving calculations. Candidates were able to recall expressions for pH or K_c , they could take square routes and use logs but then some would fail to convert correctly moles of gas to volume of gas dividing by 24 rather than multiplying by 24, while others struggled in 4 (b) to work out the number of moles in a given volume of a certain concentration. In fact in many scripts the ability to manipulate a simple expression such as $a = b/c$ would have gained those candidates a significant number of marks.

Comments on Individual Questions

- 1) (a) (i) The majority of candidates picked up these two initial marks with only a handful giving graphs that did not intersect with the y axis.
- (ii) Although slightly more demanding than the first part most candidates again picked up this mark by drawing tangents to the curve at $t = 0$. A few candidates clearly knew that rates could be obtained by drawing tangents but forgot that, these tangents must be at $t = 0$ to obtain the initial rate.
- (iii) For most candidates this was again a relatively easy mark and almost all candidates were able to recall that a first order reaction will yield a constant half-life.
- (iv) This was well answered by the vast majority of candidates. Where errors did occur they arose either from candidates who confused this sketch with the one required in part (a)(i) or from others who sketched a number of graphs to show the difference between zero-, first- and second-order. A number of weaker candidates drew plots appropriate for the change in the concentration of a reaction product with time.
- (b) There were very few errors made here with nearly every candidate using the data in the table to determine the correct order of reaction with respect to KI.
- (c) (i) Again this was very well answered. Of those who did not pick up this mark a common error was to forget to include the concentration of $C_2H_4Br_2$ in the rate equation.
- (ii) Calculating the value of the rate constant was generally well handled even by the relatively few candidates who had failed to give a correct rate equation in part (c)(i). The determination of the appropriate units was more challenging

although here again the majority of candidates were successful. It is surprising how many incorrect answers are proposed in which (i) s^{-1} is missing and/or (ii) the sign of the dm is not -3 times the sign of mol. This is such a simple check for units and yet seems rarely applied.

- 2) (a) This part saw the full range of possible equations that could take methane and water and generate hydrogen as one of the products. It was slightly surprising that the most simple of these where the oxygen of water is simply transferred to methane to give methanol did not stand out as the most common answer.
- (b) (i) This was extremely well answered with only a handful of candidates failing to use square brackets.
(ii) Despite the correct expression being given in part (i) many candidates found it challenging to use this to obtain a value for the ammonia concentration. Most of the mistakes here lay in the rearrangement of the expression for K_c or in forgetting to cube the hydrogen concentration.
- (c) This question was well handled by the majority of candidates who gave a well structured response which, although on some occasions lacked the necessary depth, nevertheless showed an awareness of most of the key points. The point most often omitted was that an increase in pressure will result in an increase in reaction rate. Where almost all candidates knew that increasing the temperature or the use of a catalyst would also increase the rate, a significant number did not explain why this was the case in sufficient detail to merit awarding these marks.
- (d) Although on the face of it this was not too challenging a calculation, it did present a number of tricky obstacles which many candidates failed to navigate correctly. The first of these was to convert 1.3 million tonnes into the correct mass measured in grams. Many candidates struggled here, presumably failing to note either 'million' or 'tonnes' in the question and so obtaining a value for the amount of ammonia that was out by a factor of 10^6 . A second common error was to work out the volume of oxygen rather than that of the volume of air as asked for in the question. Finally many candidates did not convert the amount of water into a mass of water in order to work out its volume and instead gave answers of $4.8 \times 10^x \text{ cm}^3$.
- 3) (a) Although a large number of candidates did score both marks here, there were a significant number who focussed solely on explaining the meaning of 'weak' and forgot to add the fact that a *Brønsted–Lowry* acid is defined as a proton donor.
- (b) Often this calculation was extremely well handled and candidates picked up all three marks with ease. A few candidates forgot to take the square root in their working despite the fact that they were often working from the correct expression.

- (c) (i) Despite having been asked on many previous papers, there were again a small number of candidates who failed to get this mark by talking about constant pH. The majority, however, gave the correct answer.
- (ii) Most candidates suggested that sodium methanoate could now be added to the solution to make it function as a buffer although a significant number opted for sodium hydroxide. By way of explanation the most popular answer was to identify sodium methanoate as the salt of the weak acid.
- (iii) Of the three parts to (c) candidates found this the most challenging. Of the points that were needed to gain both marks, the strength of the acid was that which was the more often quoted. A significant number of candidates identified the need to know the concentration of the acid but forgot about the concentration of the salt. Sometimes the answers were rather vague or simply linked pH to the proton ion concentration.
- (d) Although the calculation of the pH of a strong acid should be simpler than that of a weak acid, candidates more often failed to pick up these three marks than those in part (b). Rather surprisingly a significant number of the candidates simply ignored the fact that the solution is 65% and so calculated the pH based on a mass of 1400 g of HNO_3 . Less surprising was the number of candidates who were clearly unsettled by obtaining a negative value for the pH and simply quote the answer dropping the sign.
- (e) It was very depressing to see how few A-level candidates were able to give a correct equation here. Some struggled with the formula of limestone but even of those who knew this as CaCO_3 there were many who gave simply ludicrous products.
- (f) This was very well answered by all but the weakest candidates. The correct pairs were identified and their link *via* the possession of a proton was established.
- (g) (i) As in part (e) this equation presented candidates with a considerable challenge. Despite being given four of the five species involved many candidates were left at a total loss. It was surprising how many of the correct answers involved a molar ratio of 4 : 1 of HNO_3 to S, since if the given species are put in the equation it is clear that the products are simply short by one N and hence the other product must be $\frac{1}{2}\text{N}_2$.
- (ii) Candidates were generally more confident with identifying the oxidation numbers involved.
- 4) (a) Few candidates approached this problem in the most logical way: that being to work out first the mass of chlorine, then the mass of iron and hence the formula of the iron chloride. Instead most candidates approached the problem from both ends. First they worked out the number of moles of silver chloride and then proceeded to prove that this was consistent with the iron chloride being FeCl_2 . The extent to which this approach was planned or relied rather more on serendipity was not always easy to judge. Weaker candidates rarely got beyond working out the number of moles of silver chloride.

- (b) The initial part of this question was reasonably well answered and a large number of candidates were able to calculate the molar mass of the acid. Very few candidates failed to take into account the factor of 10 linking the 25 cm^3 volume of solution used with the total 250 cm^3 volume of the solution. Most of the candidates who calculated a value of 86 proposed a carboxylic acid with four carbons although a significant number forgot that they were aiming for an unsaturated acid as stated at the beginning of the question and so drew butanoic acid. Very few candidates proposed more than one isomer. More surprisingly, of the marks that were least often awarded here, the mark for the molecular formula came high on the list with some candidates simply forgetting that this had been asked for.

2816/03: Experimental Skills 2 Practical Examination

General Comments

The number of candidates entered for this option showed another increase this year. The quality of the vast majority of scripts was very pleasing. The Evaluation section was done better than normal, perhaps because the questions were shorter and most candidates had rather more time than on previous papers to think about their answers. The standard of the Plans was not quite as good as usual, mainly because many candidates were unable to describe with sufficient clarity and precision how they would determine the order of reaction.

Comments on Individual Questions

PLAN The quality of the Plans was not as high as on most papers. The description of a titration has become a fairly routine part of these exercises. For the most part, candidates answered well. The most difficult aspect for many candidates is the calculations. It is essential that candidates explain their working clearly, rather than present a jumble of figures in the hope that the Examiner will be able to decipher the logic. Candidates were expected to explain why the dilution procedure they had chosen for the hydrogen peroxide was suitable. A range of possible dilution methods would be suitable, but it was expected that candidates would attempt to justify clearly the one they had chosen, by showing that this would lead to a sensible titre.

For the kinetics part of the Plan, a number of suitable alternatives were available, all of which could score full credit if they were described in sufficient detail. The simplest option involved measuring the volume of oxygen produced at frequent intervals until the reaction ceased. The graph of volume of gas against time could then be analysed to show the constant half-life. Discussion of half-life was also the most straightforward way to interpret the data from a sampling procedure of the mixture

Most candidates attempted an initial rates method, with varying degrees of success. Key steps in the procedure were sometimes not explained with sufficient clarity – for example the need to control the mass of catalyst used for different initial concentrations of peroxide or exactly how the initial rate would be determined from the data recorded.

Some students attempted a procedure which was not the heterogeneous catalytic decomposition required by the question set. Use of potassium iodide would result in a redox reaction at the concentration of H_2O_2 supplied and therefore the volume of oxygen produced (if any at all) would be unreliable. Iodine clock-type experiments were therefore unsuitable for the task set and only a very limited number of marks could be awarded to such descriptions.

TEST

Part 1 Although the monitoring technique involved in this iodine-clock experiment was probably novel for most the candidates taking this examination, most of the timing data produced was of very respectable quality. Accuracy marks were awarded both by comparison with the Supervisor's times and by self-consistency of each candidate's own times.

Part 2 In (a) some candidates mixed up iodine with iodide ions when attempting to link the number of moles of peroxide with thiosulphate.

In (b) very few candidates indeed had any difficulty calculating the missing log value.

The quality of graphs in (c) was somewhat disappointing. Most candidates chose rather awkward scales for their axes and then penalised themselves by failing to plot the points with sufficient accuracy. Some students were not in possession of a sharpened pencil to enable them to draw a neat best-fit line.

Many good attempts at part (e) were seen. However, some students chose 'postage stamp' intercepts when determining the gradient. Getting the unit for the first-order rate constant correct proved challenging.

In (e), the favourite answer was to suggest the order with respect to sodium thiosulphate, despite the very first line on the question paper. A few candidates gave very thorough answers, but most clearly did not understand the principles underlying determination of the order of a reaction.

Part (f), by contrast, was generally very well answered.

Part 3 The easy opening question (a) was answered well.

In (b) most candidates were aware of the need to repeat readings to enhance reliability. However, fewer discussed the fact that their data had produced a good best-fit line.

Most candidates gave a reasonable answer to (c), but few considered procedural issues such as the need to increase the volume of KI used or the need to alter the log expression in order to analyse the data.

In (d), most students realised that the use of excess KI meant that precision in measuring its volume was not important, but fewer realised that the longer time needed to run out 10 cm³ of solution from a pipette would be a disadvantage. Many tried to argue that the pipette was actually less accurate than the measuring cylinder.

Answers to (e) were often handicapped by poor use of language. A range of sensible suggestions were credited, so long as Examiners could understand what the candidate was trying to say.

In (f), weaker candidates made the sensible suggestion of leaving out the final result, or treating it as an anomaly. The most able candidates realised that a log value of 0.274, rather than 0.259, should be plotted on the graph.

Advanced GCE (Chemistry) (3882/7882)

June 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	47	41	35	29	24	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	48	41	34	28	22	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	95	86	77	68	59	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	95	86	77	68	59	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	89	78	68	58	48	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	69	61	53	46	39	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	68	60	53	46	39	0
	UMS	90	72	63	54	45	36	0
2815B	Raw	90	69	61	53	46	39	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	68	61	54	47	40	0
	UMS	90	72	63	54	45	36	0
2815D	Raw	90	68	60	52	44	36	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	69	61	53	46	39	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	97	87	77	67	58	0
	UMS	120	96	84	72	60	48	0

2816B	Raw	120	97	87	77	67	58	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	91	80	70	60	50	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3882	300	240	210	180	150	120	0
7882	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3882	20.7	39.7	57.8	73.3	86.1	100	14835
7882	29.9	55.3	74.1	88.0	96.2	100	11113

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication.

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