GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Report on the Units

January 2007

Oxford Cambridge and RSA Examinations

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REPORT ON THE UNITS

Chief Examiner's Report

General Comments

As is usual for January, the two main entries were Foundation Chemistry (15,213 candidates) and Chains, Rings and Spectroscopy (nearly 8,000 candidates).

In addition, nearly 5,769 candidates took the AS Chains and Rings examination, the majority being resit candidates also sitting 2814. It is clear that more candidates are taking advantage of this resit opportunity to enhance marks from the early 'AS' units.

Nearly 90% of candidates entering Foundation Chemistry, unit 2811, were doing so for the first time. The entry for 2811 was up from January 2006 by nearly 1,000 candidates.

The entry for How Far, How Fast?, unit 2813/01, was down by about 200 candidates compared with January 2006 reflecting a shift in entry pattern across the January and June sessions. Resit candidates made up about 90% of the entry.

As in previous January sessions, about half the entry carried forward coursework, with the remaining candidates roughly evenly distributed between the coursework and practical examination components.

Over 1,100 candidates were entered for Trends and Patterns. As in previous sessions, the most popular optional units continue to be Biochemistry and Transition Elements. Environmental Chemistry and Gases, Liquids and Solids are no longer being offered in the January session.

The entry of 2816/01 was again only small (300 candidates) and, except for one large centre, dominated by resit candidates.

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.

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 Exam

A2

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

Options

2815	A	Trends and Patterns + Biochemistry
2815	B	Trends and Patterns + Environmental Chemistry
2815	C	Trends and Patterns + Methods of Analysis and Detection
2815	E	Trends and Patterns + Transition Elements

2811: Foundation Chemistry

General Comments

As with last January, this paper discriminated extremely well producing the full range of marks from 0 to 60.

Very able candidates were able to demonstrate considerable chemical knowledge and understanding, achieving very high marks.

Weak candidates often collected the majority of their marks from question 1. As has often been the case in the past, structure and bonding continues to be the most difficult area of chemistry for most candidates. Question 4 proved to be particularly testing with many candidates showing confusion with both the type of particle involved and the type of bonding. This was also reflected in question 5(c).

A significant number of marks were available to candidates who had learnt specification content thoroughly. Seven marks were available for definitions: *isotopes*, *empirical formula*, *ionic bond*, *covalent bond* and *electronegativity*. There were also a further nine marks available in question 2(a), (c) and (d) for recall from the calcium chemistry. Well-prepared candidates clearly benefited but those who had learnt little of the specification content were clearly at a great disadvantage.

Comments on Individual Questions

1) (a) Only the weakest candidates failed to score this mark. The commonest incorrect response was that 'the number of electrons are the same in isotopes'; this is incorrect for ions of isotopes.

(b) The majority of candidates correctly calculated the A_r value. Fewer candidates than in previous years made an error in significant figures. A common error was the use of the number of neutrons in place of the mass number of each isotope.

(c) A surprisingly large number of candidates, including the very able, gave their answer as Rb: 85.5.

(d) This part tested the trend in ionisation energies down a group in a different context from other papers but there was no evidence that this caused candidates any problems. Many candidates responded in the expected way: in terms of increased atomic size, increased shielding and decreased attraction down the group. The commonest omission was not to use the comparison 'more' with shielding. There was also the usual confusion between 'attraction' and 'charge'. The best candidates also considered that the number of protons also increases down a group but that this effect is outweighed by increasing atomic size and shielding.

(e) (i) This part was poorly done overall. Many candidates were able to give part of the answer containing some of the key words but often not all: *e.g.* a ‘ratio’ but no indication of ‘what’ or ‘simplest’. The examiners were expecting a definition in terms of the simplest whole number ratio of elements in a compound.

(ii) Despite the unusual compound, many candidates could calculate the empirical formula correctly with comparative ease, scoring the two available marks. Common errors were to place the expressions upside down or to use atomic numbers instead of relative atomic masses.

2) (a) (i) Most candidates suggested a value in the acceptable range of 8–14, with only very weak candidates ‘guessing’ incorrectly.

(ii) Good candidates gave correct equations, but many responded with incorrect state symbols: $Ca(OH)_2$ as (s) or $CaCO_3$ as (aq). Many candidates seemed to just make up an equation, which was inevitably wrong, reflecting inadequate preparation for the examination rather than ability.

(iii) Many candidates were able to give the correct observation that the solution goes clear although some gave many contradicting observations listing all possible observations that might be seen in a reaction.

Well-prepared candidates gave the correct formula of the product as $Ca(HCO_3)_2$, many candidates seemed to make up the answer, with $CaCO_3$, $Ca(OH)_2$ or $Ca(HCO)_2$ being seen often.

(b) (i) Almost all candidates gave the correct configuration, the commonest error being inclusion of the 4s electrons.

(ii) This was a harder mark to achieve with many candidates giving responses that included use of M_r, or the Avogadro constant. Only the top performing candidates gave the correct answer of 3.

(iii) This mark was achieved only by the best candidates. Many candidates tried to work out how many electrons were present but usually errors had been made somewhere.

(iv) Most candidates scored a mark for correctly showing a Ca^{2+} ion, with an outer shell containing either eight electrons or no electrons. Although the second mark for showing two OH^- ions was achieved by far fewer candidates, a significant number of A/B candidates were successful and this mark discriminated very well at the top end.

(c) Well-prepared candidates often achieved all four marks with comparative ease but there were many candidates who responded with random equations, often reacting $CaCO_3$ directly with water. This question allowed candidates who had revised thoroughly to demonstrate their knowledge and they were rightfully rewarded for their preparation.

(d) The majority of candidates gave the correct response. Common incorrect answers included the use as fertilisers, toothpaste and antacids.

3) (a) A large number of correct responses were seen, obviously memorised. Some candidates did not clarify the opposite charge nature of ions in their definition of ionic bonding.

(b) (i) When marking this question it was difficult to determine whether the candidate was really answering about electronegativity, with responses about 'attracting electrons' often omitting the source as the electrons in the covalent bond. A common misunderstanding was to include polarisation and the attraction of electron clouds from anions. Well-prepared candidates gave mark scheme perfect answers and easily collected both marks. Weak candidates most often scored zero.

(ii) Most candidates scored one mark for drawing a bond with correctly labelled dipoles. A large proportion of candidates supported this with a clear statement about difference in electronegativity.

(c) The majority of candidates showed a correct hydrogen bond between two water molecules but fewer candidates showed the hydrogen bond going to an oxygen lone pair.

4) (a) Well-prepared and able candidates easily picked up three marks. However this question really highlighted the lack of revision of some candidates with impossible responses such as 'simple metallic' and 'simple ionic'.

(b) Most candidates find difficulty in explaining properties in terms of bonding and structure. Although the most able candidates could explain this clearly enough, the majority of candidates often contradicted themselves in muddled answers. It was common to see descriptions of strong ionic or metallic bonding in carbon which could change into covalent bonding in the next line. Many candidates thought that silicon has a higher boiling point than phosphorus because it had more covalent bonds, rather than different types of forces being involved.

(c) Again this question rewarded well-prepared candidates who were able to explain clearly the increase in delocalised electrons and cationic charge and link these to increased strength of metallic bonding. Common errors were not clarifying that the electrons are delocalised or statements that the ions were getting bigger/ larger rather than the ionic charge increasing. Many weaker candidates answered this part in terms of a larger nuclear charge increasing the attraction for outer electrons, and these candidates had not interpreted this question.

Both (b) and (c) tested candidate's understanding well.

5) (a) (i) Most candidates were able to correctly calculate the number of moles of HCl as 0.60.

(ii) Most candidates scored at least one mark here by multiplying a calculated number of moles by 24. Unfortunately for weaker candidates, the number of moles was often incorrect, the commonest error being to not divide the HCl moles by 4. However, most candidates gained both marks here for a volume of 3.6 dm^3.

(b) This part differentiated very well with above average candidates correctly identifying the reduction of Mn and the associated change in oxidation numbers. Many weaker candidates incorrectly proved that chlorine had been reduced, perhaps because redox properties of chlorine have been tested in many previous papers.

(c) (i) A reasonable number of candidates scored two marks here, although scoring 1 mark was more common. Candidates most commonly forgot to balance the equation or did not show Cl_2 as diatomic. Surprisingly the state symbol of Na was often shown as (aq).
The weakest candidates often showed: $Na^+ + Cl^- \rightarrow NaCl$.

(ii) Candidates clearly struggled with drawing a 3D structure, with many candidates failing to show alternating Na^+ and Cl^- ions. It was not uncommon to see structures labelled with Na and Cl atoms instead of ions, '*dot-and-cross*' diagrams of ionic bonding or statements such as a 'giant covalent structure'.

(d) Responses to this question ranged from poor to very good. Almost all candidates could correctly state a decreasing trend in reactivity from Cl to Br and I, but fewer correctly explained this trend in terms of atomic size, oxidising power or attraction for electrons. The equations are obviously being well taught and practised by candidates from many centres. Observations were in general correct and most candidates had been taught the organic solvent colours. The mark scheme allowed for colours in either the organic or aqueous layer and the inclusion of the organic solvent clearly made this question fairer than in the past (in which responses such as 'purple for iodine' could not be credited).

Most candidates were awarded the mark available for Quality of Written Communication.

2812: Chains and Rings

General Comments

This was a sound paper with good specification coverage. Candidates seemed well prepared, with most scoring in excess of 30 marks. This is to be expected as most of the candidates were A2 students repeating the unit as part of their second year of the course. Only a few candidates scored in excess of 50 marks which, again, is to be expected as the very best candidates would have scored well in their Chains and Rings examination in June 2006.

The questions were accessible to all and differentiated well across all abilities. This was particularly true for questions 1, 2 and 3. Question 4 was very straightforward and almost all candidates scored well. Question 5 proved to be low scoring even for the most able. Yet again candidates struggled to express themselves clearly and concisely.

The responses to the two mechanisms were interesting. Question 4(a) required recall of a familiar mechanism and very many candidates scored all six marks. In question 2(c) an unfamiliar mechanism was given in full and candidates struggled to demonstrate their understanding of the fundamental principles of mechanisms and the curly arrow notation used by chemists. Few, if any, scored all four marks.

Comments on Individual Questions

1) (a) This was straightforward with most scoring the mark. A substantial number confused fractional distillation with cracking.

(b) Most scored the mark but a substantial minority ignored the instruction in the question to produce propene and wrote an equation forming any alkene.

(c) (i) Most scored the mark but many drew a trivalent carbon at the methyl carbon and others drew both a ring and a chain structure.

(ii) This was well answered but a substantial number forgot the H_2.

(d) (i) This was well answered.

(ii) Drawing isomers still presents problems to many candidates. Many seemed to score the marks accidentally rather than by a systematic approach. Many drew 2-ethylpentane, which actually scored the mark for 3-methylhexane.

(iii) This was very straightforward with most scoring the mark.

(iv) Most understood the principle but many failed to express themselves precisely.

(e) (i) This was generally well answered.

(ii) This was poorly answered. Very many incorrectly stated that ‘ethanol could be burnt and then burnt again, hence it was renewable’.

2) (a) (i), (ii) Fermentation was not well known. Many did not know the products or the conditions and few scored the mark for state symbols.

(iii) (iii) This was reasonably well answered, although many stated reasons that could not have been observed.

(b) (i), (ii) Both parts were well answered.

(c) (i), (ii) This was a challenging and thought-provoking question which discriminated well. Few recognised that H^+ behaved as catalyst.

(d) This was poorly answered with very few scoring both marks. As expected, very many forgot the oxygen in the alcohol.

(e) This was well answered.

3) (a) This was extremely demanding and discriminated well, with only the most able scoring the mark.

(b) This was straightforward, although many failed to score a mark a mark by drawing an incorrect bond linkage from the carbon backbone to the CH_2Cl.

(c) (i) The structures of **F** and **G** proved to be more demanding than expected. Often the OH group disappeared.

(ii) Many recognised that HBr was required but very many failed to balance the equation correctly. In desperation, a substantial number changed HBr to HBr_2 in an attempt at balancing.

(iii) This again proved to be demanding. To be awarded both marks, candidates needed to state that the reagent was a dichromate, which had to be acidified and heated under reflux. This proved challenging to many candidates.

(iv) This was well answered but many lost the mark by displaying the aldehyde as COH instead of CHO.

(d) This was well answered.

4) Overall candidates found this question easy and it was not uncommon for candidates to score maximum marks.

(a) This was straightforward and many scored all six marks.

(b) This was very straightforward with almost all scoring three out of three.

(c) This was well answered with many applying their understanding and deducing a correct response for part (iii).

5) This was very poorly answered. Diagrams of the π-bond were generally incorrect. Most stated a bond angle but many failed to state the shapes.

Many didn't appreciate, or forgot, that the shape and bond angles in the methyl group were different from the shape and bond angles of the other two carbons.

The explanation of *cis-trans* isomerism was generally well answered.

The mark for quality of written communication proved to be difficult to attain.

The quality of expression and written communication often hindered the scoring of the chemistry marks.

2813/01: How Fast, How Fast?

General Comments

Most candidates had clearly prepared for this unit and generally coped well with those questions that were similar to those of previous examinations. There was, for example, a significant increase in the number of correct ionic equations seen and many correct answers to the enthalpy based calculations. The level of understanding of rate and equilibrium based ideas was also generally encouraging.

However, questions that were phrased slightly differently, and hence aimed at testing students' **understanding** of the basic concepts of the unit material, often produced disappointing answers. This was particularly noticeable in Q.1(b) since many candidates totally misinterpreted the information given on the graph. Candidates should be advised to look carefully at the labels on the axes, when data is presented graphically, and not just assume that they recognise the shape of the curve.

Apart from the most able, candidates also apparently found it difficult to present their ideas logically. In Q.4(b) for example, many of the ideas, of both rate and equilibrium position, were somewhat muddled and unfocussed.

Comments on Individual Questions

1) (a) (i) Most candidates correctly balanced the equation but many gave magnesium carbonate as being aqueous or magnesium chloride as being a solid.

(ii) As already noted, it was encouraging that more candidates gave correct ionic equations than have been seen on previous occasions. Answers based on the use of $MgCO_3$ or CO_3^{2-} were both accepted.

(b) Many candidates appeared to look at the shape of the graph drawn and assume that it showed an increase in **rate** with time. Explanations therefore often involved an increase in temperature allowing more molecules to exceed the activation energy or more collisions happening as time went on. In some cases there was obvious confusion with enzyme-catalysed reactions and reactions ceasing to change when equilibrium had been attained.

(c) (i) Most candidates realised that, if a weak acid was used, the reaction would be slower but a significant number also thought that less gas would be produced when the reaction was complete.

(ii) The idea that weak acids are only partially dissociated was generally recognised but few candidates then linked this to a lower concentration of hydrogen ions in the solution.

Q2 (a), (b) The equation for the combustion of propane and the definition of the standard enthalpy of combustion were generally correct.

(c) (i) Most candidates recognised that $mc\Delta T$ was needed and most were able to insert the correct numerical values. Some used the mass of propane and others quoted their answer in J, whilst stating it was in kJ.

Ans: 42.1 kJ

(ii) Most candidates used mass/M but credit was not given if the answer was approximated to one significant figure.

Ans: 0.0227 mol

(iii) Most candidates again clearly understood how to convert their energy term into the enthalpy change of combustion but many omitted the negative sign.

Ans: -1850 kJ mol^{-1}

(c) As noted above, most candidates gained some credit for the calculation of the enthalpy change. There were however a large number of cases in which numbers were being used with little chemical understanding. Very few totally correct Hess cycles were seen and many candidates were clearly confused about the signs that should apply.

Answer: 207 kJ mol^{-1}.

(d) (i) Candidates scoring all available marks generally drew a logical cycle. Others tended to use the numbers given, generally with the correct multipliers, but in a less understandable manner. This often led to at least one error.

Ans: -107 kJ mol^{-1}

(ii) More able candidates recognised that a variety of hydrocarbon products would be produced if carbon reacted with hydrogen or that it was difficult to persuade any reaction to occur between the elements. Weaker candidates produced answers based on errors in other situations, such as heat loss or the variation in bond enthalpies.

3) (a) Apart from a few candidates who confused the concentrations of the reagents and products remaining constant with their being the same as each other, most could quote two features of a reversible reaction.

(b) (i) Most candidates gave an acceptable definition of a catalyst with only a small minority stating that a catalyst is not involved in the reaction.

(ii) The significance of ‘homo’ was understood but, in order to gain credit, it was necessary to state that it was the catalyst that was in the same state as the reactants.

(iii) Most candidates correctly deduced that H^+ was acting catalytically.

(iv) Although this question has been asked in previous sessions, only a minority of candidates stated that the rates of the forward and reverse reactions were affected equally.

(c) (i) Most graphs drawn were acceptable.

(ii) A few graphs corresponding to a change in temperature were seen but most candidates attempted an explanation bases on a lowering of the activation energy.

4) (a) A wide range of conditions was allowed so that most candidates were able to quote acceptable values. Some candidates apparently had problems with units – these were occasionally omitted but more often were confused so that, for example, a value that would have been acceptable in °C was quoted as being in K.

(b) As already noted, many answers lacked the structure to really address all the considerations used in the decision of the compromise conditions needed in the Haber process. Many responses were limited to the use of le Chatelier's principle and its implication on the equilibrium position. Few candidates explained the effect of temperature on the rate of attainment of the equilibrium and even fewer considered the effect of pressure on rate.

2813/02: Coursework 1

General Comments

The entry for the coursework option is very limited in January and consists almost wholly of candidates re-submitting work which was considered unsatisfactory in the previous June session. Although some of the work received this time had clearly benefited from the experience gained it was disappointing that so many candidates had done little to improve on the quality of their work. The Moderators also felt that some issues clearly raised in the individual reports previously sent to Centres were being ignored by those assessing the work and this led to some inflated marks. Details, such as including initial burette readings (skill I) or providing sufficient details for the references supplied (skill P), are required for the award of 7 and this level cannot otherwise be accepted.

At AS, there is strong evidence that candidates find it easier to obtain marks if they use the proformas provided in the Coursework Guidance booklet and it needs to be emphasised once again that it is intended that Centres should provide their students with this framework. This is particularly so for skill E where nearly all candidates find it harder to reach the higher levels. It was, for example, a shame to see thoughtful evaluations failing on the grounds that no attempt was made to identify the significant errors which are specifically requested on the proforma.

Comments on Individual Skills

In many ways the standard of the work seen for skill P has risen over the last few years and many of the plans showed a good understanding of the overall strategy required to formulate an experiment which would resolve the problem posed. However, a significant weakness was the failure to provide a detailed procedure for the experiment. For example, candidates requiring to dilute hydrochloric acid in the exemplar ‘Limewater’ experiment specified a 10 cm^3 pipette but used it to measure a volume of 2.5 cm^3 without further comment. Or, in the same experiment, failed to mention the colour changes of the indicator expected during the titration. Of course this does not prevent candidates obtaining a good mark but it does mean that they have fallen short of providing ‘a detailed plan which could be used by others without modification’ as expected at P7a.

As usual, marks were generally high for skill I with only a limited number providing less than satisfactory observations. Skill A was also well attempted although using significant figures to reflect the accuracy of the equipment used is something of a mystery to some. A somewhat cavalier approach to units being the other area where marks were readily lost.

Although candidates were usually successful at identifying procedural and measurement errors when tackling skill E their suggested improvements were often vague or unworkable.

In the relative atomic mass of lithium exemplar an escape of hydrogen cannot be guaranteed by replacing the measuring cylinder by a syringe or by just adding the lithium more quickly: a method must be described which allows the lithium and water to be mixed once the bung has been replaced. Equally to suggest that the accuracy of the measurements would be improved by using a ‘better balance’ does not suffice without further explanation as to what the word ‘better’ might mean.

Skills I and A were usually well marked but skill E was less satisfactory with the identification of significant errors expected for the award of E5b once again being ignored by some.

2813/03: Practical Examination 1

General Comments

The standard of most scripts was encouraging, with most candidates able to make reasonable attempts at most parts of the paper. Few scripts were awarded very high marks, but there were very few that achieved very low marks. The Plan involved just one experiment, so the description required by the Mark Scheme was more detailed than normal.

Comments on Individual Questions

Plan A Most candidates, even weaker ones, were able to pick up many of the marks for the basic aspects of the Plan. Descriptions of gas collection were the most common. Candidates who chose to describe a mass loss experiment were usually not careful enough when stating what would have to be weighed at the start and end of the experiment: an initial weighing after the acid had been added to the baking powder was often unhelpfully suggested. Few candidates were aware of the considerable length of time needed before all the carbon dioxide would diffuse out of the reaction flask. Weighing to constant mass at the end of this experiment is essential for accuracy. A few candidates measured the carbon dioxide by absorption in soda-lime (or another suitable alkali). This method has the same major drawback as the mass loss method.

Diagrams drawn by hand should make use of a ruler and be of approximately the right proportion. On this plan two marks were available for research into, and a brief statement about, the typical composition and the simple chemistry of operation of baking powder. Few candidates scored both of these marks and many did not attempt to include any relevant background information. Most candidates calculated correctly the maximum mass of $NaHCO_3$ that could be used so that the collecting vessel did not over-fill, but a few did not explain why their calculation was being carried out. Answers were weaker in terms of some of the precautions needed for accuracy. Use of excess acid, appropriate separation of reagents and problems caused by solubility of the carbon dioxide were often only mentioned by better candidates .

Most candidates wrote up their Plans well and scored both of the quality of written communication marks. However, some fail to include a word count and others are careless in their precise use of units and chemical formulae. Once again, on this Plan, candidates are prone to over-state the hazards of chemicals. $NaHCO_3$ was occasionally described as "toxic" and sulphuric acid was frequently described as "corrosive" and "causes burns" without any attempt being made to relate this to the specific concentration of acid used in the Plan.

Test B **Part 1** The standard of accuracy achieved by most candidates in this procedure was remarkably high: many scored all three available marks. A few candidates were careless in their use of significant figures (two decimal places in the norm for all weighings) and some subtracted the wrong figures when attempting to calculate the mass of residue.

Part 2 This proved to be more challenging. In (a), most candidates were unable to produce a valid second observation. The question included reference to "bubble(s)" so this type of observation was not accepted. Examiners were looking for either a reference to condensation or to the appearance of the residue in the tube that had been heated. A significant number of candidates were unable to deduce, despite their observation of "fizzing" in (b)(i), that the residue was sodium carbonate. Many chose one of the two other alternatives given on the question paper and thought that the gas was hydrogen.

Part 3 For the majority of candidates, who had failed to correctly identify sodium carbonate as the residue, the number of marks available was inevitably limited, even though "error carried forward" marking was used. This Part proved to be the lowest scoring in the practical examination. Even students who knew the correct identity wasted marks by failing to quote calculated answers to three significant figures (not three decimal places), as required. Unfortunately, 83 was often suggested as the relative formula mass of sodium carbonate.

Part 4 This Part was very well answered by many candidates. The accuracy of the temperature drop measured (compared with the supervisor) was extremely good and many candidates were able to complete the ΔH calculation on page 9 without difficulty. Very few were tempted to put a negative sign in front of their endothermic answer. A disappointing number of candidates failed to act on the instruction to record temperatures to the nearest 0.5 ^{o}C. Examiners therefore expected that 22 ^{o}C would be recorded as 22.0 ^{o}C.

Part 5 Weaker candidates performed better than usual on the Evaluation section, as there were a number of relatively straightforward marks available. In (b), answers based either on the lower temperature or on the sooty nature of the yellow flame were both credited in responses. However, few students explored both factors, despite the word "reasons" (plural) in the question. Many answers in (e) were disappointing because students failed to home in on the major errors (inadequate insulation and inaccuracy of the thermometer used) and, instead, wrote about relatively trivial factors such as amounts of solid remaining in the weighing bottle or the difficulty of reading the thermometer while they were stirring with it. In (d), candidates were expected to write about the need to repeat the experiment in order that consistent readings obtained would be evidence of reliability.

2814: Chains, Rings and Spectroscopy

General Comments

The paper produced a good range of marks with many Centres clearly preparing their candidates very well. Many candidates were able to demonstrate a thorough knowledge and understanding of the ideas covered in the specification. A greater number of candidates were able to provide high scoring answers than in previous years. 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 comfortable answering questions that require them to apply their knowledge and understanding in unfamiliar contexts. There were relatively few very poor scripts, although a few clearly do find the subject very demanding at this level.

Some candidates still seemed to be unfamiliar with the additional assessment objectives that were added to the specification from the January 2006 series onwards. Teachers should check that they are now using the Revised Edition of the specification for teaching from September 2004.

Most candidates seemed to finish the paper in the time allowed.

Comments on Individual Questions

1) (a) Most candidates identified Tollens' reagent as a suitable reagent to identify the aldehyde, although some did not identify butanoic acid or its salt as the organic product. The specification does require knowledge of chemistry behind this reaction in addition to the commonly known observation. There were a variety of ways to identify the unsaturated alcohol, including reaction with an acid chloride to give a sweet smelling ester. Many candidates, however, used their knowledge from the AS Chains and Rings unit to suggest decolourisation of bromine by an addition reaction.

(b) This was well answered by many candidates who spotted that measuring the melting points of the purified precipitates would distinguish the two carbonyl compounds. Measuring the boiling points is still however a common incorrect answer.

(c) Most candidates were able to interpret the parts of the given spectrum of butanone and correctly suggest the remainder. They needed to use the lack of splitting to identify that peak **A** was due to the CH_3 next to the carbonyl group. There were some interesting attempts at drawing a triplet, although candidates were not penalised as long as three peaks were clearly seen.

2) This question allowed candidates to demonstrate their knowledge of the condensation polymerisation of α-amino acids to give a polypeptide. Many knew this topic well although, for full credit, it is essential to concentrate on the chemistry and not get distracted by the biological details. A few candidates confused polypeptides with nylon or Kevlar. For full credit, the peptide linkage had to be identified and the structures did need to show polymerisation using bonds extending at each end, rather than just two amino acids combining to give a dipeptide. Candidates also needed to relate the variety of proteins to the many different sequences possible with the varying R groups in the amino acids.

3) (a) Nearly all candidates correctly deduced that addition polymerisation must be responsible for the formation of Perspex from the given monomer.

(b) Many could also complete the syndiotactic structure given and candidates found this much easier than drawing these 3-D structures from scratch. For the last part, candidates had to identify that the other possible arrangement would be isotactic, having the side group on the same side along the regular structure.

(c) Precisely identifying the reagents and conditions for the given synthesis proved more challenging. For a reagent, we do need to know what bottle the student would get out to do the reaction, and not just give more general terms like ‘acid’. For the hydrolysis a suitable aqueous strong acid, such as dilute HCl or H_2SO_4 must be chosen. This must be heated, ideally under reflux, to allow hydrolysis of the nitrile to occur at a reasonable rate. Stage 4 required refluxing with methanol and concentrated H_2SO_4 to make the methyl ester. A fair number of candidates however did not spot that this was an esterification reaction.

(d) The nucleophilic addition mechanism was well known by many candidates. The most common errors were not starting the curly arrow from the carbon of the nitrile group and the negative charge missing or only partial in the intermediate.

4) (a) A good number of candidates knew that water would be a product of reducing the nitrobenzene, although some were unable to balance the equation. Some did seem unsure that [H] referred to the reducing agent in particular and not just ‘hydrogen’. A few candidates had not read the question well enough and incorrectly suggested reducing agents other than the tin and conc. HCl used in this case.

(b) Most candidates made a good attempt at constructing this equation to show the deprotonation of the phenylammonium chloride to give the phenylamine, a salt and water.

(c) Candidates found this calculation easier than those on some of the previous papers. Most could calculate the theoretical yield of phenylamine from the given M_r values as 2.793 g. However, a significant number did not then go on to allow for the 72.1% yield stated in the question. As in part (a), it was clear that some candidates had attempted the question without reading the question carefully enough.

(d) Most candidates were able to gain some credit on this part by identifying the lone pair on the nitrogen atom and recognising that electrons were drawn from this into the benzene ring in phenylamine. However, many went on to write about the inductive effect, which is not the main factor in determining the basicity of aromatic amines. The inductive effect acting along the σ bond pushes electrons towards the nitrogen, not away from it. It does this slightly less than in ethylamine, but this was not the focus of this question. To obtain full credit it must be made clear that the lone pair is being partially incorporated into the delocalised π-bonding electrons around the aromatic ring.

5) (a) Only the best candidates knew the use of PCl_5 or $SOCl_2$ to substitute the OH group for a chlorine atom in a carboxylic acid. To score both marks, candidates also needed to know the inorganic products in either case. ***NOTE!*** As this content has been added to the specification since the publication of many of the textbooks and revision guides used by the candidates, teachers may need to stress these additional reactions more thoroughly to prevent them being overlooked.

(b) Many more candidates were however able to deduce an equation to hydrolyse the ethanoyl chloride back to the carboxylic acid.

(c) Most candidates recognised that a broad peak in the range 2500–3300 cm^{-1} would be present for ethanoic acid, although candidates were penalised if they quoted the range for alcohols and phenols instead. Further marks could be obtained by also identifying the range 1000–1300 cm^{-1} for the C–O bond, that the carbonyl peak would now be in the range 1650–1750 cm^{-1}, or that the C–Cl peak at 600 cm^{-1} would not be present.

(d) Most candidates knew that mass spectrum was that of ethanoic acid, but to obtain full credit candidates needed to show how this was deduced by identifying the molecular ion peak at a m/e value of 60, which was equal in value to the M_r of ethanoic acid.

6) (a) For this part a reagent that reacted with phenols and not with alcohols was needed. Decolourising bromine water was the most common correct answer although other valid responses with correct observations, such as NaOH(aq) and neutral $FeCl_3$ were also accepted. Candidates generally found this harder than the chemical tests earlier in the paper.

(b) Nearly all candidates identified the chiral centre in noradrenaline, but only a few spotted that compound **P** would have two chiral centres. However, many candidates had a good attempt at drawing the optical isomers of noradrenaline. To obtain full credit, valid use of the 3-D 'wedge' and 'dotty' bonds was needed and the groups had to be connected to the chiral carbon by the correct atom. See the mark scheme for examples of correct representations. Candidates do need to practise drawing these to become confident at 3-D representations.

(c) Many candidates knew that a drug containing a mixture of stereoisomers could result in harmful side-effects and the need for higher doses. However, for full credit candidates also needed to explain that this was because only the correct isomer would have the right 3-D shape to be pharmacologically active.

7) 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 the p orbitals and the 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, the planar shape of the ring with 120° bond angles, or identifying that σ-bonds form all the other covalent bonds in the molecule. For the quality of spelling, punctuation and grammar mark, bullet points are fine, but sentences without capital letters are increasingly prevalent.

8) (a) The more able candidates were not put off by the unfamiliar context of this reaction and correctly identified that chlorododecane or similar would be needed with a suitable halogen carrier such as $AlCl_3$. Those who got this far were usually able to write a suitable equation as well. Most candidates however still recognised that a hydrogen atom from the benzene is replaced by the alkyl group.

(b) This was a new context for the electrophilic substitution mechanism, but most candidates felt confident to apply what they knew and had a good attempt at drawing the intermediate and the relevant curly arrows for each stage. When drawing the intermediate, some candidates drew the positive charge beside the tetrahedral carbon rather than in the centre to show that it is delocalised around the remainder of the ring.

(c) A pleasing number of candidates deduced that the natural breakdown of the given sorbitan monolaurate molecule would be by hydrolysis of the ester bond to produce an alcohol and a carboxylic acid. However, only very few spotted that this would also be environmentally friendly because the molecule is made from a renewable source, whereas the sodium dodecylbenzenesulphonate is made from crude oil.

2815/01: Trends and Patterns

General Comments

The marks awarded to candidates suggest that this paper was a little more demanding than in previous sessions. The average mark for the paper was 23.5 and the range of marks was from 1 to 45. A significant percentage of the candidates scored less than 10 marks and often their examination papers were full of gaps. Despite this, there was no evidence that candidates ran out of time.

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 of the candidates' answers to quantitative questions were poorly organised with very little structure. As a result it was often difficult to award error carried forward marks. Although there were no marks awarded for the correct use of significant figures candidates often used too few or too many significant figures.

Many candidates did not use chemical terminology with precision. In particular the terms atoms, ions, molecules, compounds and elements were often used in the wrong context. This was particularly apparent in question 4 when explaining the difference in lattice enthalpy.

Comments on Individual Questions

1) This question was focussed on the oxides of elements in Period 3. It combined aspects of synoptic assessment, particularly structure and bonding and balancing equations. Candidates found this question quite demanding and a significant proportion of the candidates scored 2 or less out of a maximum of 7 marks.

(a) Many candidates described the trend rather than explaining the trend in chemical formula. A common misconception was to refer to the type of bonding, the type of element involved (metal or non-metal) or the number of electrons. Good answers referred to the number of outer electrons or to the oxidation state of the element in Period 3.

(b) Only a small proportion of the candidates scored a mark for this question. Many referred to the inability of electrons to move but this was not given credit. Candidates had to refer to ions not being able to move. There was evidence that some students did not understand the term electrical insulator and explained why magnesium oxide conducts electricity.

(c) (i) Very few candidates could write the balanced equation and a number of strange species were given as products. The formula Al_2Cl_6 was not accepted in the equation.

(ii) Only a small proportion of the candidates could balance the equation.

(d) Candidates had to refer to the strength of covalent bonds or the large number of covalent bonds that had to be broken for one mark and needed to express that this would need a large amount of energy for the second mark. It was not sufficient to repeat the information from the table about silicon(IV) oxide being a giant covalent compound. There were several misconceptions involving giant ionic structures and very strong intermolecular forces.

(e) Many candidates were able to predict in that an acidic solution would be formed. Often the answer was supported by a correct equation.

2) This question involved the chemistry of mercury and hydrogen peroxide. Candidates found parts (a) and (b) much less demanding than the synoptic material in part (c).

(a) A large proportion of candidates was able to get at least one mark. This was usually for identifying that mercury is being oxidised, together with the correct change in oxidation number. Many candidates did not understand that the oxidation state of oxygen in hydrogen peroxide was –1 and so had hydrogen being reduced.

(b) Almost all candidates were able to apply the information about the electronic configuration of mercury.

(c) (i) The '*dot-and-cross*' diagram was often well drawn but a small fraction of candidates drew a double bond between the oxygen atoms. Other misconceptions involved having two hydrogen atoms bonded to the same oxygen atom.

(ii) Only an extremely small number of candidates were able to use electron-pair repulsion theory to predict the bond angle. The majority of candidates did not realise that the number of lone pairs and bond pairs around an oxygen atom was the same as in a water molecule. Many candidates did not realise that the theory must be applied to one 'central' atom and applied the theory to the whole molecule. They gave answers such as the lone pairs repel equally so the molecule is linear. Another misconception was that with four lone pairs the bond angle will be reduced by about 10^o.

3) This question was focussed on the chemistry of iron(II) and iron(III). It combined aspects of synoptic assessment and knowledge and understanding from the Trends and Patterns part of the specification. A greater proportion of the candidates obtained high marks in this question than in the previous two questions. A small but significant proportion of the candidates did not attempt the calculations.

(a) The correct answer of Fe_2Cl_6 was given full credit providing it was supported with some working out. Although most candidates recognised that this calculation involved an empirical formula, many could not effectively interpret the data. A common misconception was not to work out the mass of chlorine from the data; these candidates often used 487 mg as the mass of chlorine.

A significant proportion of the candidates did not use the given molar mass either to get the correct formula or to decide that their calculated empirical formula was incorrect. Other candidates did use the molar mass and worked out the ratio of the moles of iron to the moles of the compound (two moles of Fe in every mole of compound). This was given the same credit as working out the empirical formula.

(b) Candidates found this part relatively easy and many gave the answer of simple covalent and used the information given to support either the simple structure or the covalent bonding. Only a relatively small proportion of candidates gave answers such as simple ionic.

(c) (i) Many candidates got the correct answer but a small proportion of candidates gave $1s^22s^22p^63s^23p^63d^44s^2$.

(ii) The majority of candidates could draw the shape of the octahedral complex, with only a small number drawing square planar or tetrahedral. Fewer candidates gave the correct bond angle; some left it out and others gave the tetrahedral angle.

(iii) The mark scheme in required the formation of a green precipitate or a green solid. Many candidates did not include the precipitate or the solid. In the ionic equation the majority of candidates either ignored state symbols or put $Fe(OH)_2(aq)$ rather than $Fe(OH)_2(s)$.

(d) (i) Many candidates wrote the wrong formula for hexaaquairon(III) ions giving the complex ion an overall charge of +2 rather than +3. Another common error was to forget to include the water in the equation.

(ii) There was a mixture of excellent answers and very poor answers that did not refer to colorimetry at all. The best answers used sketch graphs to illustrate their answers and also included possible results tables. A significant proportion of the candidates described the experiment but did not go on to explain how the results could be used to confirm the formula of the complex ion.

(e) (i) Many candidates wrote the correct ionic equation but a small proportion of candidates wrote equations involving Fe and Fe^{2+} or the reduction of Fe^{3+}.

(ii) Only a small proportion of candidates were able to calculate the percentage purity. Answers between 66.3 and 66.5 were allowed on the mark scheme.

Two approaches were used by candidates.

Approach 1

- Calculate amount of Fe^{2+} that reacted = 0.0077 mol
- Calculate mass of MnO_2 that reacted = 0.335 g
- Determine percentage purity

Approach 2

- Calculate amount of MnO_2 if sample was pure = 0.00580 mol
- Calculate amount of Fe^{2+} that would have reacted with this pure sample = 0.0116 mol
- Calculate amount of Fe^{2+} that actually reacted = 0.0077 mol
- Determine percentage

The majority of candidates failed to get even the first steps correct.

4) This question focussed on the Born-Haber cycle and lattice enthalpy.

The question also included one mark for the quality of spelling, punctuation and grammar. To be awarded this mark, candidates had to write at least two sentences that addressed the question set and had no significant errors of spelling, punctuation and grammar. A significant proportion of candidates could not be awarded this mark because they did not write any sentences and just carried out the calculation and the Born-Haber cycle.

Although many candidates answered the questions in the order of the bullet points others concentrated on the qualitative parts first and left the Born-Haber cycle and the calculation until the end.

Many candidates did not write the correct equation associated with the lattice enthalpy of magnesium chloride. The most frequent error was the omission of state symbols. A majority of candidates gave the correct definition for lattice enthalpy although two common misconceptions were that it was the energy required and that lattice enthalpy involves the gaseous elements rather than the gaseous ions.

Most candidates drew Born-Haber cycles as energy level diagrams and labelled the species and energy changes. One mark was awarded for all the correct formulae in the cycle and one for the correct state symbols. Many candidates were awarded one mark out of the two available.

The correct value for the lattice enthalpy was -2526 kJ mol^{-1} but many candidates made errors because they did not double the enthalpy of atomisation of chlorine or the electron affinity of chlorine. An error carried forward mark was allowed for these errors.

Candidates tended to use the terms *atom*, *ion* and *molecule* as though they meant the same thing when trying to explain why the lattice enthalpy of $MgCl_2$ was more exothermic than that of NaBr. Another similar misconception was to refer to the charge density of NaBr or $MgCl_2$. Candidates were only penalised once within the question for such errors. Good answers compared the ionic charges and the ionic radii of the ions involved and then made a comment about the electrostatic attraction between the ions.

2815/02: Biochemistry

General Comments

The entry was slightly smaller than last year, with only three Centres fielding more than 20 candidates. The standard of the work seen seemed to be slightly higher than is usual in January with a higher proportion of the entry scoring 30 marks or more. The great majority of candidates showed sound knowledge and an ability to apply ideas across the full range of the subject. They coped well when individual questions touched on several areas of the specification. The best candidates expressed their ideas well and, in places, they revealed understanding well beyond that required. Weaker candidates often expressed themselves badly or, more damagingly, failed to understand the wording of the questions.

Comments on Individual Questions

1) (a) (i) Almost half the entry drew a correct open-chain structure of deoxyribose. The near misses were often a ketone or 3-deoxyribose.

(ii) Most candidates had no difficulty in choosing similarities between DNA and RNA, but a number described the similarities between ribose and deoxyribose instead.

(iii) Nearly all candidates answered this correctly. The commonest error was to discuss function rather than structure.

(b) This was answered well by most candidates. Some excellent answers went well beyond specification requirements in describing Okazaki fragments, RNA primers and the role of ligase and helicase enzymes. Some thought that a polymerase assisted the unwinding of the double helix; the main role of this enzyme is to catalyse the formation of the phosphate ester links in the growing chains. Most candidates mentioned the involvement of both hydrogen bonds and van der Waals' forces in holding the double helix together.

(c) (i) Several candidates attempted a description of transcription and/or translation; they scored very few marks.

(ii) Half the candidates scored both marks. Some failed to mention the actual bases involved. Others did not refer to translation or the role of t-RNA (an alternative mark).

(iii) Nearly all candidates scored well here, showing a good understanding of the role of side-chains (R groups) and intramolecular forces in maintaining the shape of the active site.

Nearly all answered this part correctly as TAAAGACCA. A few wrote the complementary m-RNA sequence by mistake.

2) (a) (i) Most candidates drew the correct structure, but several showed the structure the wrong way around.

(ii) Most referred to the involvement of three fatty acid residues in a triglyceride and only two in a phospholipids. It was not enough to state only that the triglyceride did not contain phosphate or, worse, phosphorus.

(iii) All but the very weakest candidates labelled the diagram correctly.

(b) Many candidates referred to the importance of matching/complementary shapes for substrate and active site, although some incorrectly suggested that the shapes needed to be the same. The second mark was for referring to the position of the R groups in the active site, which actually carry out the catalysis. Very few mentioned this.

(c) Whilst many referred correctly to the removal or hydrolysis of fats or fatty stains, others answered in more general terms or referred to proteins. 'Lipids' was not enough.

(d) (i) The rate increases because the substrate concentration increases whilst there are plenty of enzymes/active sites available. Many candidates found difficulty in expressing their answers sufficiently well to score the mark. Many referred to amounts of substrate rather than concentrations.

(ii) This part was attempted much better. Most candidates knew that the flattening to a constant rate is due to the active sites/enzymes becoming saturated with substrate. Perhaps half went on to explain why this leads to a constant rate. A few thought that the reaction stopped at this stage.

3) (a) Nearly all candidates scored both marks, although some who used an extended molecular formula ran into trouble. The correct answer for that would be $H_2NCH_2CONHCH[(CH_2)_4NH_2]COOH$. A few did not choose the correct amino acids.

(b) Most candidates knew that the ionic attractions in the tertiary structure would be affected. Many were able to show the correct structures of their exemplar amino acids at high and low pH. However, only half of these described the changes in ionisation as starting from the fully ionised forms with both COO^- and NH_3^+ groups present in the molecule.

(c) (i) Nearly all knew that non-competitive inhibitors bind onto the enzyme somewhere other than at the active site. Many mentioned allosteric sites, although this was not necessary for the mark.

(ii) Cysteine in the middle of a protein chain will interact with the heavy metal ion through its SH group, forming, for example, $-SAg$ and H^+. Those who started from disulphide bridges were awarded the mark. Those who used the COOH or COO^- group were not credited, although this is the main way heavy metal ions denature proteins - by interfering with ionic attractions. It should be noted that magnesium is not a heavy metal.

(d) (i) There were many good descriptions of the quaternary structure of haemoglobin. Better candidates referred to the role of intermolecular forces in holding the four sub-units together. The use of the prefixes α and β triggered the reflex addition of the words helix and pleated sheet by some candidates, often without the mention of polypeptide or protein.

(ii) Most scored the mark for binding oxygen. Many scored also a second mark for some chemical detail such as the reversibility of the binding. Several mistakenly implied that the Fe^{2+} in the middle of each haem group was oxidised during binding. Weak candidates referred only to the function of haemoglobin in a biological sense as oxygen carriers.

4) (a) The great majority of candidates drew a 1α–4 glycoside link with correct position and stereochemistry Some lost the stereochemistry mark by leaving both the hydrogen atoms on C1 and C4. The 1α–6 link proved more difficult to locate, and several candidates were left with an extra OH group on C6 in their final structure.

(b) This question about the relationship of the structure of cellulose to its function was well answered by many candidates across the ability range. They described the role of hydrogen bonding between linear (unbranched) cellulose molecules in forming the microfibrils and fibrils, which give the polymer its tensile strength. They also referred to its insolubility. Too many candidates did not read the question with enough care so that answers were often given in terms of amylose or amylopectin. This rarely earned more than a mark for identifying solubility. Others had neglected this part of the specification.

2815/04: Methods of Analysis and Detection

General Comments

Very few candidates appeared to be taking this option for the first time and the range of marks obtained by those re-sitting the paper was very wide. Those who had taken the opportunity to study the option in greater detail obtained marks that were comfortably above thirty but a number who appeared to be unprepared and confused offset this.

Many found it very difficult to assemble answers that clearly addressed the question that had been asked and often these candidates also struggled to provide a logical framework to a sequence of deductions. This is an area where much practice is needed. A further concern was the number of candidates who either did not use the *Data Sheet* at all or who made errors in quoting the relevant data. It appeared perhaps that many were viewing the sheet for the first time in the examination. Simple marks were available for providing accurate information and it was a pity to see these marks so readily squandered.

Nonetheless there were also some impressive scripts where marks were only really lost through an occasional lack of precision or careless use of English.

Comments on Individual Questions

1) (a) Explanations of the two terms were usually good and most candidates were able to obtain the marks.

(b) (i), (ii), (iii) Again these parts were well answered although a few candidates confused gas/liquid chromatography with thin-layer chromatography.

(iv) There was some confusion here. Although many knew that the area under a peak gave a measure of the amount of that component, they then seemed unable to relate this as a percentage of the whole.

(c) (i), (ii) Both parts of this question were very well answered and marks were usually only lost through lack of precision.

2) (a) (i) Many candidates found this hard to explain clearly. The key point that was required was an indication that the energy levels were discrete.

(ii) Although most understood that the lines of the spectrum are created when electrons fall from higher to lower energy levels, only very few appreciated that a drop to a different energy level created each set of lines. A minority of candidates answered in terms of an absorption spectrum rather than an emission spectrum.

(iii) This question was well answered.

(iv) Possibly this proved to be the most difficult mark to obtain. Only the very best candidates seemed able to understand that the ionisation energy related to the movement of the electron to its ground state. The most common reason given was simply to state that hydrogen has only one electron.

(v) A few managed to obtain the correct answer and remember to quote it to three significant figures but some could do little more than quote the relevant formulae and then wilt at the prospect of handling the various powers of ten. For the better candidates a common error was to forget to use the Avogadro constant.

(b) (i) Usually the correct species were identified.

(ii) Some did not read the question carefully enough and attempted to explain much more than the question had asked.

3) (a) In order to score the marks for the similarities within each infra-red spectrum, the appropriate range for the functional group as stated on the *Data Sheet* was expected. Many failed to do so and lost relatively easy marks. It was only rarely noted that there would be differences in the infra-red fingerprint region. The difference in the fragmentation peaks of the mass spectrum was however generally recognised.

(b) Good answers were invariably provided here.

4) (a) The relationship between the M and the M + 1 peak of the mass spectrum had mostly been learned but some ignored the factor 1.1 and concluded that 9 carbon atoms were present.

(b) This was quite a complicated molecule to identify from its spectra so it was pleasing that a good number managed to obtain the correct answer. Less satisfactory was the candidates' ability to assemble the important evidence to provide answers, which had a clear structure. Nevertheless the marking scheme allowed for a variety of approaches and it was therefore possible for all candidates to obtain some credit and for several to achieve full marks. The weakest point was perhaps associating the number of protons from the n.m.r. spectrum to the possible structural feature. Some, for example, used the *Data Sheet* to suggest several possibilities for the group causing the peak at 2.3 ppm but failed to recognise that three protons had to be present.

2815/06: Transition Elements

General Comments

A good range of marks were seen. Few candidates scored low marks and comparatively few centres entering candidates with little grounding in the subject, which was an improvement on some previous years.

A majority of scripts were legible and diagrams, when used, were clear and helped candidates to achieve better marks. Quantitative chemistry is still a problem and the depth of knowledge required to answer questions on colour in transition metal complexes was not always evident.

Most candidates attempted to answer all the questions and there was no suggestion that time played a factor on this paper.

Comments on Individual Questions

1) (a) (i) This was an easy start to the paper but quite a few candidates did not respond with +3.

(ii) Most candidates correctly chose **C**. 3-D diagrams are now being used in all but a few cases.

(iii) There was some confusion here but a majority responded with the correct type of stereoisomerism, *cis*-*trans* or geometric.

(b) (i) This was generally well-answered but Cl^- was **not** accepted as a reagent.

(ii) Most candidates recognised this as ligand substitution.

2) (a) Many candidates know this definition. Quite a large number did not include the actual standard conditions in the definition but these were then used in the diagram in (b). This was credited.

(b) Diagrams of the cell were usually of a good standard. Occasionally candidates forgot to draw in the liquid level and a few electrodes were not in contact with liquid, particularly for the hydrogen half-cell.

(c) (i) This was very disappointing. Few candidates seemed to know that the end point for this titration was an off-white precipitate. The common answer was brown to colourless or blue to colourless if starch was used.

(ii) This caused real problems for a number of candidates. Even good candidates often lost a mark by omitting to scale down by a factor of 10 to account for dilution. It was common to see the correct answer of 0.93 mol dm^{-3} written down from a calculation that gave the answer of 0.093 mol dm^{-3}.

(iii) Candidates needed to state that 0.93 mol dm^{-3} or a concentration less than 1.00 mol dm^{-3} or standard to obtain a mark here before proceeding to explain how this would affect the position of equilibrium and the value of $E^{\ominus}$.

3) (a) Good candidates were able to explain the role of a ligand in the splitting of d-orbitals and the changes in colour which follow. Weaker candidates find this part of the specification difficult and easily become confused. Weak answers tended to concentrate on a discussion of the colour wheel rather than an understanding of the size of ΔE in determining what colour a particular complex has by virtue of the frequency of light absorbed when promoting an electron from a lower energy d-orbital into a higher energy d-orbital.

(b) Candidates continue to improve on this type of question. The common mistake here was to suggest that the compound was purple because green was strongly absorbed. The maximum absorbance is clearly in the blue region of the visible spectrum, suggesting the complementary colour of yellow for the complex.

4) (a) (i) Most candidates used stainless steel as the example here. Some lost marks for omitting a specific use, *e.g.* ‘chromium is used to make car parts’. The minimum needed was ‘chromium is used to **plate** steel because it is attractive or because it resists rusting’.

(ii) A surprising number of candidates did not remember the $3d^5 4s^1$ configuration of chromium.

(b) (i) Too many equations were seen with residual electrons

(ii) Most candidates correctly calculated a emf of + 0.56 V

(c) (i) Orange to green was a common mistake here.

(ii) Many candidates failed to state that OH^- ions react with H^+ ions as the reason why equilibrium moves to the right.

5) (a) Most candidates recognised that the lack of colour in Cu^+ ions was due to the d^{10} configuration. Fewer explained the need for a vacancy in the d-orbitals before electrons can absorb visible light and be promoted.

(b) (i) Pigment or dye was accepted here along with the weaker answer of 'used in paints'.

(ii) Most candidates recognised the bonding as dative covalent or co-ordinate.

(c) Many good candidates scored well here. Common mistakes were to suggest that the blue solution was copper hydroxide and the red-brown solid was copper(I) oxide. A common mistake seen in the equation was to not recognise the need for two Cu^+ ions when forming Cu^{2+} and Cu.

2816/01: Unifying Concepts

General Comments

As in previous January sessions, Centres with an entry of only one candidate dominated the entry with many resit candidates from the previous June. The total entry of just over 300 candidates came from nearly 100 centres.

The quality of the work seen was very mixed with truly excellent candidates being interspersed with some extremely weak candidates. There seemed to be more weak scripts than in previous January sessions. One Centre provided a large number of candidates and the work of these candidates better represented the full ability range.

Rates and equilibrium posed few real problems for the majority of candidates but the questions testing acid-base equilibrium proved to be much more testing. Many candidates found Question 4 extremely difficult and weak candidates would often struggle to score even one mark in this question. In contrast 'A' candidates responded well to the challenge of this question, often scoring all 7 marks.

The truly synoptic Question 5, set in the context of sulphuric acid, tested many different areas of chemistry, discriminating extremely well.

Comments on Individual Questions

1) (a) (i) Candidates are mostly very comfortable with problems involving the initial rates method and this part proved to be a relatively easy starter to the paper. Surprisingly, the second order factor of 3 for [NO] seemed to pose less difficulties than the first order factor of 2.5 for [H_2], with some candidates instead vaguely stating 'just over 2'.

Almost all candidates expressed themselves clearly and were awarded the mark for quality of written communication.

(ii) Most candidates used their results from (i) to construct a rate equation.

(iii) This calculation caused few problems to most candidates. When errors did occur, these were usually in the form of an incorrectly rearranged equation or with incorrect units.

(b) (i) Candidates found this part more difficult than anticipated and there was a reluctance to cancel species occurring on both sides of the equation. Some candidates changed ½O_2(g) to O(g). Most candidates who identified NO as the catalyst were able to explain its action as being used and then regenerated.

(ii) The majority were able to show a rate equation using the species in the slow step.

2) (a) The K_c expression was correctly shown by all but the very weakest candidates, although a few chose to show an expression for K_p instead.

(b) (i) It was pleasing to see how many candidates were able to tackle this part successfully.

(ii) The best candidates were able to explain that the system would be out of equilibrium and that concentrations would adjust to generate a ratio with the correct K_c value. Many explanations, however, stated that the equilibrium would move to the left because the K_c value is less than 1. This suggests that some candidates had obtained the correct answer to part (i) using flawed logic.

(c) (i) The majority correctly stated that K_c would not change but the examiners also required some statement that K_c only changes when the temperature changes.

(ii) Most candidates correctly stated that the increase in pressure would be opposed with the equilibrium moving to the left as the side with fewer gaseous molecules.

(d) (i) Again, the majority correctly identified that K_c would decrease.

(ii) It was pleasing to see how many candidates could correctly deduce that the forward reaction must be exothermic and that the equilibrium position would move to the left to oppose the temperature increase.

(e) (i) Most candidates correctly balanced the equation.

(ii) The calculation was answered pleasingly well with above average candidates being able to derive the correct answer without prompts. The commonest mistake was a failure to use a factor of 4 when calculating the amount of PCl_5. Weaker candidates made more basic errors, often when calculating the M_r values. For many candidates though, this part provided four easy marks.

3) (a) (i) Surprisingly few candidates knew that K_w is called the ionic product of water. For some able candidates, this was the only mark dropped in question 3.

(ii) Most candidates correctly showed the expression for K_w. The examiners accepted expressions including either H^+ or H_3O^+. The commonest mistake was division by $[H_2O]$.

(b) Above average candidates solved this unstructured problem with comparative ease. However, below average candidates often got completely lost with the numbers in the stem often being used at random.

(c) Candidates found this part more difficult and only the best identified that $[OH^-]$ would be twice that of $Ca(OH)_2$. The correct answer of pH = 11.73 was seen only from the best candidates with many candidates producing 11.43 by not using the factor of 2 above. It was disappointing to see how many candidates just calculated the –log value of $[OH^-]$ to give an answer of 2.27, an impossible pH value for an alkaline solution.

(d) This part foxed all but the very best candidates. The answer of 8 tested real understanding of pH and could be deduced from logic rather from lengthy calculations that were often seen, usually resulting in an incorrect wrong answer.

4) (a) In contrast to the equation in Q2(e)(i), candidates found great difficulty in constructing this equation. The mistake seen on many papers was a formula of Ca_2SO_4 for calcium sulphate.

(b) Good candidates successfully applied their understanding of acids to show a correct equilibrium. Many however seemed to use species rather at random and it was disappointing to see the number of response with different total charges on either side of the equilibrium, with an array of impossible species.

(c) (i), (ii) Candidates produced muddled responses here, repeating the problems of part (b). Part (ii) was correct more often than part (i).

(iii) Most candidates found this part beyond them, often deciding to write instead about buffers in general. In contrast, the best candidates applied their understanding well and often secured all three available marks.

5) (a) Most candidates identified that sulphuric acid molecules would hydrogen bond together and it was pleasing to see the number of responses showing a correct dimer. For all three marks, the examiners required a statement that the hydrogen bonds would need to be broken on boiling and that this would require extra energy.

(b) Overall, there were some very good responses to this part with average to above candidates usually constructing at least 2 out of the three equations. Common mistakes arose when candidates chose to use sodium carbonate and hydroxide, with $NaSO_4$ being seen often as one of the products. Surprisingly, and perhaps sensibly for many, acid salts were seen on many occasions and this approach was credited as correct chemistry.

(c) Most candidates were able to show correct oxidation numbers for iodine but those of sulphur proved to be more elusive. Only the very best candidates correctly constructed the equation, the difficulty being the need for $4I_2$ and $8I^-$ to account for all electrons. Correct equations had usually been balanced using oxidation numbers.

(d) This part differentiated extremely well. Many candidates correctly identified **A** as CO and a correct equation was common.

For **B**, many did not recognise the black solid as carbon and the commonest response was $C_{12}H_{20}O_{10}$. It was also common to see **B** as C_{12}. Candidates who were successful in identifying **B** were usually able to construct the equation.

More candidates were able to identify **C** as $C_4H_8O_2$ and to write a correct equation. Above average candidates were also able to suggest a possible structure for **C** and the examiners credited any feasible structural isomer of $C_4H_8O_2$. The commonest seen was ethyl ethanoate. The actual product of this reaction, 1,4-dioxane, was seen very rarely, only in the scripts of the most able candidates.

2816/02: Coursework 2

General Comments

The entry for the Coursework option is very limited in January and consists almost wholly of candidates re-submitting work which was considered unsatisfactory in the previous June session. Although some of the work received this time had clearly benefited from the experience gained it was disappointing that so many candidates had done little to improve on the quality of their work. The Moderators also felt that some issues clearly raised in the individual reports previously sent to Centres were being ignored by those assessing the work and this led to some inflated marks. Details, such as including initial burette readings (skill I) or providing sufficient details for the references supplied (skill P), are required for the award of 7 and this level cannot otherwise be accepted.

Comments on Individual Skills

In many ways the standard of the work seen for skill P has risen over the last few years and many of the plans showed a good understanding of the overall strategy required to formulate an experiment which would resolve the problem posed. However a significant weakness was the failure to provide a detailed procedure for the experiment.

At A2, by far the most popular choice for the assessment of skill P was the identification of an organic unknown. Many of the flow charts were sound although the reaction of phenol with bromine was not always appreciated. The description of the tests was however less satisfactory. Candidates cannot be allowed P7b if essential details of appropriate quantities are missing. An example might be the necessity of using 2,4-dinitrophenylhydrazine in excess when testing for a carbonyl group.

Skills I and A were usually well marked but skill E was less satisfactory with the identification of significant errors expected for the award of E5b once again being ignored by some.

2816/03: Practical Examination 2

General Comments

As usual, the January entry for this paper was small. Most candidates were well prepared for the examination and a few candidates scored very high marks indeed. Teachers and lecturers who supervise Practical examinations are reminded that most accuracy marks for their students are allocated by comparing students' results with their supervisor's. In this examination, supervisors were asked to carry out the gravimetric experiment in Part 1 twice in order to improve the reliability of their results. However, not all supervisors followed this instruction.

Comments on Individual Questions

Plan A

The first section of the Plan, identifying traces of Fe^{3+} ions, proved to be easy marks for most candidates. A few omitted to mention the need to use acid, in order to dissolve the iron(III) oxide.

Most candidates scored well on the second section. The gas collection was described clearly and the vast majority of candidates were able, as requested, to justify suitable quantities of reagents to use for the experiment. To score the marks for this, candidates were not expected to make use of the actual typical composition of calamine lotion, nor to allow for the zinc hydroxide when calculating the amount of acid needed, though it was pleasing to see that many were able to do so. Two marking points often omitted were the need to shake the suspension of calamine thoroughly before measuring it out, and that the method was based on the fact that zinc carbonate was the only component of calamine that would give off a gas when an acid was added.

The third section was not as well done, perhaps because candidates are less familiar with qualitative filtration techniques. Few were aware of the potential inaccuracy of suspension passing through normal laboratory grade filter paper, and the precaution of washing the residue before drying to constant mass was rarely mentioned. In the overall calculation of the % of $ZnCO_3$ in the solid material in malachite, many candidates omitted to scale up the two sets of results so that they would relate to the same quantity of calamine used. In their risk assessment section, many candidates described HCl as corrosive, even though they were using it at a low concentration.

Test B

Part 1 The standard of accuracy achieved by most candidates in this procedure was very high. However, it was disappointing that a significant minority subtracted the wrong figures when attempting to calculate the mass of residue.

Part 2 Many candidates scored all five marks on this section. Some failed to act on the instruction to quote answers to three significant figures, while some others had difficulty using the mole ratio in the last section.

B (cont)

Part 3 The quality of recorded qualitative observation remains disappointing. Only a minority of candidates referred to formation of a precipitate in the second section on page 6. By contrast, the standard of accuracy in the titration was very pleasing indeed, bearing in mind that the end-point was much less distinct than in most common titrations. A small number of candidates wasted a mark or two by failing to record the mass of **X** used and the mean titre.

Part 4 This Part of the paper discriminated well. Many good candidates had no difficulty at all with this calculation. Weak candidates struggled, although they were often able to achieve a correct answer in (e). Section (c) proved to be the most difficult, since candidates had to use the mole ratio from the equation (without confusing iodide ions with iodine) and do the scale-up. In (d) a few candidates who had omitted the scale-up factor of 10 “fiddled” their answer for the relative formula mass, thereby losing another mark: “error carried forward” marking was used in (d).

Part 5 A number of candidates performed well on this section, although there was some evidence that a few students ran out of time whilst attempting it. Section (a) was often answered well, although a number of students remain unclear about the fact that consistency of repeated readings for the whole procedure is what constitutes reliability. Answers to (b) were variable. Many students did not act on the instruction to *compare* the two techniques and, as a result, wrote ambiguous statements in their answers.

In (c), only the most able candidates made allowance for the reaction of the copper(II) hydroxide in malachite with the acid, as well as the carbonate. Too many candidates tried to attempt the question without any attempt at a chemical equation for the reaction. However, many were able to comment correctly on why the relatively large volume of acid had been used.

Advanced GCE Chemistry (3882/7882)
January 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	D	e	u
2811	Raw	60	47	41	35	29	23	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	47	41	35	30	25	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	94	85	76	67	59	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	94	85	76	67	59	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	89	80	71	63	55	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	73	66	59	52	46	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	66	59	52	45	39	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	68	60	52	45	38	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	67	59	52	45	38	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	96	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	96	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	90	79	68	57	46	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	14.6	35.2	53.6	77.1	92.7	100.0	401
7882	16.5	59.1	78.3	93.0	98.3	100.0	136

437 Candidates aggregated this series.

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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