GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Report on the Units

June 2006

3882/7882/MS/R/06

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Chief Examiner's Report

General Comments

This June's session saw entries rise across all units. For AS aggregation, entries increased from 12724 in June 2005 to 14192 for June 2006. For A2 aggregation, entries increased from 9270 in June 2005 to 10291 for June 2006.

The overall standard of work increased with a slight improvement in results for most units. The most popular optional units continue to be *Biochemistry* and *Transition Elements*. Although most units worked extremely well, this was tempered by problems in each of the organic units. In 2812, Question 2, there was an ambiguous structure of isoprene and many teachers contacted OCR with their concerns. In 2814, aspects of Question 6 were criticised by some teachers for going beyond the demands of the assessment outcomes in the specification.

In both cases, Examiners made every effort to ensure that candidates would not be disadvantaged. The problems, and measures to resolve them, are discussed in detail later in this report. Teachers are thanked for bringing their concerns to the attention of the examining teams.

On a more positive note, candidates from approximately 30 Centres piloted an Alternative to Practical Examination (2813/04) in order to assess their practical and investigative skills at AS level. This innovative approach has been well received by most of the participating Centres.

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 examination

A2

2816	A	How Far, How Fast? + Coursework
2816	B	How Far, How Fast? + Carry forward coursework mark
2816	C	How Far, How Fast? + Practical examination

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	D	Trends and Patterns + Gases, Liquids and Solids
2815	E	Trends and Patterns + Transition Elements

INSET dates for Autumn 2006

Get started *– successful first delivery*
A full day course aimed at giving teachers/Centres new to OCR AS/A level chemistry a useful guide to delivering the course.
Course dates and codes Thursday 21 September 2006, Birmingham (CCHR101); Saturday 30 September 2006, London (CCHR102).
Fee £120 including refreshments, lunch and course materials.

INSET dates for Autumn 2006 (continued)

Get ahead *– getting the coursework right*
A full day course aimed at giving guidance on the assessment of practical skills for AS (2813/02) and A2 (2816/02) coursework.
Course dates and codes Tuesday 26 September 2006, London (CCHR201)*****; Wednesday 4 October 2006, Bristol (CCHR202); Thursday 19 October 2006, Leeds (CCHR203); Wednesday 15 November 2006, London (CCHR204).
***** This session (CCHR201) is particularly aimed at teachers with no prior experience of coursework assessment.
Fee £120 including refreshments, lunch and course materials.

Get ahead *– improving candidate performance*
A full day course involving discussion of the AS and A2 written paper and coursework units assessed in January and June 2006 to give guidance on ways to help candidates improve their grades.
Course dates and codes Saturday 14 October 2006, London (CCHR301); Thursday 9 November 2006, Birmingham (CCHR302); Friday 24 November 2006, Leeds (CCHR303).
Fee £120 including refreshments, lunch and course materials.

Get ahead *– improving candidate performance in the practical examinations*
A half day course aimed at giving guidance on the preparation of candidates for the AS (2813/03) and A2 (2816/03) practical examinations.
Course dates and codes Saturday 7 October 2006, Birmingham (CCHR401), am; Saturday 14 October 2006, London (CCHR402), pm.
Fee £94 including refreshments, lunch and course materials.

Places may be booked on these courses using the booking form at the back of this report; we are unable to accept telephone bookings. Please quote the course code in any correspondence.

2811 – Foundation Chemistry

General Comments

Overall the paper seemed fair but marked lower than the January 2006 2811 unit. As in most sessions, the paper discriminated extremely well with marks ranging from 0 to 60. A significant proportion of the entry was made up of resit candidates and these fell into two main categories, many weak and a few strong.

One disappointing aspect of the responses seen was the ‘sloppy’ use of number. Candidates often rounded intermediate results halfway through multi-stage calculations, resulting in an error in the final answer. Questions usually indicate the required accuracy by consistent use of significant figures in data provided. Candidates should be encouraged to keep all figures in a calculator with rounding at the end of such calculations. This poor usage of number is not restricted to just the *Foundation Chemistry* unit.

Another disappointing aspect of the responses was for candidates to score poorly on questions that have not been tested for several sessions. Perhaps recent past examination papers are becoming the taught specification in some Centres. Success on such questions [*e.g*. 4(a)(iv)] was often very Centre-specific.

Comments on Individual Questions

1) (a) (i) Most candidates scored the mark here; only very weak candidates gave incorrect responses often by confusing electrons with neutrons. A few candidates muddled *isotope* with *isomer*.

(ii) Many candidates did not score the first mark here as they gave the mass of an electron as 0. The examiners expected that the electron would be shown as having mass, with ‘negligible’ being a sufficient minimum response.

Only very weak candidates failed to correctly give the charges. A small number misread the question and gave the numbers of protons, neutrons and electrons, based on an Sb atom.

(b) (i) A large proportion of candidates scored two marks only as the idea of an ‘average’ or ‘weighted mean’ mass was often omitted. Overall fewer candidates gave muddled answers and less gave the mass of the carbon-12 isotope as 12 g. The answers to this question have improved over the years, with more Centres teaching a standard response to this question.

(ii) Average to good candidates scored both marks here; they correctly spotted that four significant figures were required and gave an answer correct to this degree of accuracy. Weaker candidates either missed the four significant figures, showed four decimal places or did not understand what is meant by four significant figures at all. Only very weak candidates were not able to carry out any correct calculation here.

(c) (i) Less than half the candidates scored this mark. The most common incorrect answer was a bond angle of 120^o.

(ii) Candidates’ responses were not as clear as in previous recent sessions. Many were aware that lone pairs repel but not necessarily that bonding pairs do also. Many just related the angle to geometry, *i.e*. 360/3. The commonest error was that the lone pair repelled hydrogen atoms.

(d) (i) Only the most able candidates scored both marks here. A large number of candidates correctly calculated that 25 kg was 5% of the starting mass but many did not subsequently convert to grams. Weak candidates were unable to access this question at all.

(ii) Some candidates correctly multiplied their answer to (i) by 2 and 122. Common errors were to not multiply by 2 or to not spot that the units of the answer were required in kg, so not dividing by 1000. Whether candidates really understand that the formula $n = m/M$ is calculated in grams is questionable. Again weak candidates did not perform the correct calculation on any level.

2) (a) (i) Almost all candidates correctly identified the gas as hydrogen. Only very weak candidates did not score here.

(ii) Most candidates did not achieve this mark, with the majority writing equations containing SrO or SrOH. Surprisingly, this mark was only achieved by a very small number of top grade candidates.

(iii) Again, this was a difficult mark to achieve, although more candidates than the previous question were able to score here. Most candidates chose an explanation based on reactivity and did not scored any marks. Some were able to spot that the A_r values of Ca and Sr are different; fewer linked this to more/less moles of the metal and hydrogen. This was a good differentiator of the high grade candidates.

(iv) Many more candidates scored the mark here giving alkaline pH values. Some were penalised for contradicting themselves with two pH values, one acidic and one alkaline.

(b) (i) This question was answered poorly considering its inclusion in many past papers. Many candidates had the electron on the wrong side of the equation, had atoms forming 2+ ions or wrote full symbol equations for reactions with water or oxygen. Of those who gave a correct ionic equation, few coupled this with correct state symbols.

(ii) Candidates struggled to explain this answer, often talking about more attraction but giving no explanation. Many thought that the second electron was in a closer shell or sub-shell. Very few responded in terms of a different proton : electron ratio. The best responses considered electron repulsion of the 4s electrons in a Ca atom.

(iii) Answers to this question were good, giving the impression that Centres are teaching this answer as a 'set' response. Most candidates scored at least two of the three available marks. The mark most often missed was the idea of increased attraction from the nucleus or consideration of the outweighing of the increased nuclear charge by increased shielding and size.

3) (a) Candidates from some Centres provided near 'word perfect' answers. Other candidates were giving answers containing the word electrostatic but were unclear about the particles. Others explained the process of forming ions but not the attraction between ions. Many candidates failed to correctly identify the 'oppositely charged' nature of the ions.

(b) Able candidates scored three marks; however, as usual many candidates still showed the outer electrons present in both the metal and the non-metal ion with arrows showing movement. Quite a few candidates gave the bonding of CaO as covalent. Weaker candidates showed incorrect ionic charges, even if the electrons were correct. Surprisingly, more candidates correctly gave CO_2, perhaps indicating that Centres are teaching this molecule.

(c) This was correctly answered by many candidates, the commonest errors being the inclusion of $4s^2$ or even $3d^2$.

(d) (i) Most candidates were credited for using 56.1 for CaO. A few used atomic numbers instead of masses. Candidates then correctly calculated the moles but many lost the second mark due to incorrect rounding often by quoting the answer to one significant figure only.
(ii) Many candidates correctly applied their answer to (i) using a formula (often $n = cV$ or $n = cV/1000$) and correctly gaining two marks. Quite a few ignored the 1 : 2 stoichiometry and scored one mark overall. Rounding of the answer to (i) produced a significant error in the final answer to this part.

(e) (i) Correct answers were often Centre-specific. Most candidates had a reasonable grasp of dative bonding, although some were not awarded the mark because it was not apparent that **two** electrons were being shared.
(ii) More able candidates were able to correctly balance this equation. Weaker candidates did not score. Some candidates had obviously not read the question and used incorrect reactants and/or products. Some used an incorrect formula for calcium nitrate, despite it being provided earlier in the question.

4) (a) (i) Approximately half of all candidates failed to score this mark as they did not seem to understand the relevance of the $6H_2O$. Many omitted the water from the calculation entirely. It was also unusually common for 35 to be used for the A_r of Cl.
(ii) A reasonably large number of candidates scored this mark by either stating 'white' or a 'white precipitate'.
(iii) Very few candidates scored marks for this part. Only the most able gained one mark for the ionic equation, with fewer still getting both marks. It was common to see incorrect state symbols and $AgCl_2$ was often seen for the formula of silver chloride, presumably on the basis that a chlorine molecule is diatomic.
(iv) It seemed apparent, from the many Centre-specific incorrect answers, that many Centres have not taught this at all. Other Centres had taught this but as it has not been tested on previous papers then it had perhaps not been stressed to candidates. Only those high scoring candidates gained all three marks here. The commonest incorrect responses gave either the colours of silver halide precipitates or the colours of the halogens themselves.

(b) (i) The majority of candidates scored all three marks here, perhaps as this question has been used several times on past papers. The most common mark lost was the +1 oxidation number for Cl in HOCl.

5) Most candidates identified that Li has metallic bonding but weaker candidates often contradicted themselves by later stating that the bonding is ionic or covalent. The majority of candidates attributed the conductivity of Li to the presence of delocalised electrons. Many discussed a structure containing delocalised electrons but the presence of positive ions was seen less often. Most candidates identified that graphite is bonded covalently in a layer structure. Many also stated that the structure is giant. Candidates were less clear on the electrical conductivity, often describing the bonding and free electrons but not linking this is to electrical conductivity; instead many candidates thought that layers moved to conduct electricity
Many candidates identified that nitrogen does not conduct electricity because of the absence of mobile electrons. A large proportion also stated that nitrogen has a simple molecular structure of N_2 molecules. A much smaller portion were

able to clearly explain the low boiling point in terms of weak van der Waals' forces, with many claiming that covalent bonding is weak between atoms. The Examiners credited any correct response that linked the high boiling point of Li or graphite with the correct strong forces or bonds. This was scored regularly by able to average candidates who linked strong covalent bonds to high boiling point of carbon. Fewer chose to explain this in terms of metallic bonds but those who did often scored the mark. The commonest mistakes were responses that used the wrong particles or, surprisingly, the claim that the van der Waals' forces between the graphite layers were strong and responsible for its high boiling point.

Most candidates were awarded the mark available for Quality of Written Communication as almost all wrote a significant amount using sentences for which the meaning was clear.

2812 – Chains and Rings

General Comments

The paper produced a good spread of marks with the marks ranging from 0 to 60. Very few scored below 10; equally the top 8 or 9 marks were elusive. Weak candidates found the paper challenging and a substantial number scored between 20 and 30, whilst able candidates coped well and many scored between 40 and 50.

Question 2 (a)(i) created some confusion because of the hybrid skeletal/structural formula of isoprene. This was taken into account such that candidates were not penalised for misinterpreting the formula shown on the paper.

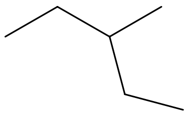
Each of the five questions was accessible to all candidates, but each question contained parts that stretched even the most able candidates. The majority of candidates seem to have been well prepared. Candidates displayed good examination technique in all of the questions and there was no evidence to suggest that candidates ran out of time.

Comments on Individual Questions

1) (a) This was very straightforward with most candidates scoring both marks.

(b) Most scored the mark but a substantial minority seemed not to have heard of fractional distillation.

(c) (i) This was generally well answered with most scoring at least one mark. Candidates are very inventive at drawing the same structure twice in a slightly different format. It was not uncommon to see 3-methylpentane drawn twice as any of the structures below.



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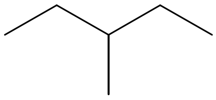

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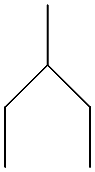

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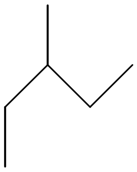


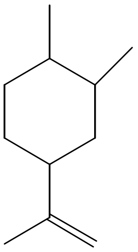
(ii) This was generally well answered.
(iii) Most scored this mark.
(iv) The explanation of the variation of boiling point discriminated well. The most able clearly explained the correlation between the amount of branching and the extent of intermolecular bonding and then went on to describe how this influenced the amount of energy required to break the intermolecular forces. Weaker candidates often confused intermolecular forces with intramolecular bonds and/or reactivity.

(d) (i) This was straightforward but many correctly drew the cyclic structure of cylohexane and then contradicted them selves by writing $CH_2CH_2CH_2CH_2CH_2CH_2$.
(ii), (iii) These parts were well answered.

(e) Able candidates scored both marks but a surprising number found this part difficult with many calculating an incorrect M_r for $(CH_3)_3COH$ and others quoting their answer directly from the calculator and ignoring the request in the question for an answer to three significant figures.

2) (a) This was generally very well answered with many scoring both marks.
It was unfortunate that a ‘C’ was not shown in the structural formula of isoprene but the Examiners compensated candidates by crediting both C_5H_8 and C_4H_8.

(b) Most scored the mark in (i) but very many failed to score both marks in (ii). It was common to see equations for partial hydrogenation. Candidates who had misinterpreted the structural formula of isoprene in (a)(i) were also given credit in this section.
The partial hydrogenation of limonene was reasonably well done but it was not uncommon to see isoprene rather than limonene. A surprising number indicated an extra C by drawing structures that revealed a misunderstanding of skeletal formulae such as those shown below.



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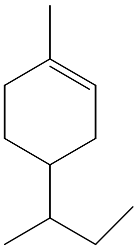


(c) (i) This was surprisingly badly answered with very many not scoring the mark.
(ii) As always the response to the mechanism was very Centre-specific and it was often three marks or none. It is important that Centres look carefully at the mark schemes to see what is required to score the marks.

3) (a) Able candidates scored all four marks but weaker candidates demonstrated a variety of errors. Many candidates do not seem to be comfortable with numbers. Percentage yields exceeding 100% were seemingly not challenged.

(b) (i) Most scored at least one mark but many failed to follow the instructions within the question and ‘put a bracket round one of the repeat units’.
(ii) This was straightforward but many lost the mark by either describing CO_2 as a toxic gas or by stating that the fumes would damage the ozone layer.
(iii) This was generally well answered.
(c) Some candidates were confused over the role of electronegativity of the halogen and others incorrectly identified C–F as the weakest bond.

4) (a) (i), (ii) Both parts were well answered.
(iii) The propagation steps still reveal a lack of understanding by a substantial number of candidates.

(b) This was poorly answered, with even the most able struggling to explain what happens to the free radicals in the termination steps.
This was answered very poorly. It appeared that few knew the required conditions and that some didn’t fully understand the meaning of ‘a solvent’.

(c) (i) This was much better answered than previous sessions.
(ii) Many found it difficult to express their answer in words and a substantial number appeared not to refer to their data sheet.
(iii) This proved to be surprisingly difficult. Many failed to identify Br_2 (aq) as the reagent and its decolourisation as the observation. Even more failed to write a balanced equation for the reaction.

(d) Many identified the catalyst but only a few deduced the correct structure of the acid.

(e) The oxidising agent was well known but the majority failed to construct a balanced equation for the oxidation.

5) Few if any scored full marks for this question. Most failed to structure their answer and often forgot to include either structural isomers or *cis-trans* isomers. A substantial number appear to have misunderstood the question and wrote at length firstly about isomerisation and then about cracking and reforming.
The quality of written communication mark appeared more elusive than usual with many failing to correctly use specific chemical terms in the correct context.

2813/01 – How Far, How Fast? (Written Examination)

General Comments

Most candidates showed awareness of the basic concepts involved in this unit so that very few scripts were seen with a significant number of the questions not being attempted.

Candidates should realise that answers requiring specific definitions to be quoted will almost inevitably feature somewhere in the paper. On this occasion both the bond enthalpy and the standard enthalpy change of formation were included and, although many totally correct answers were seen, a large number of candidates omitted significant features or wrote chemical nonsense. Whilst these definitions clearly are classified as recall, candidates would be advised to check that what they have written actually makes sense. In the definitions in this unit this means, for example, that 1 mole will almost certainly be needed somewhere.

It was encouraging to note how many correct numerical answers were given to the calculations but less pleasing to note the way in which some of the answers were derived. Candidates who merely write numbers, without logical explanation, risk scoring no marks if the final answer is incorrect.

There were a number of occasions in the paper where it appeared candidates answered the question that they were expecting, rather than the one that was actually set. Examples of this are given in Comments on Individual Questions below.
As noted in previous reports, only the most able candidates seem able to write correct ionic equations.

Comments on Individual Questions

1) (a) Most candidates recognised that carbon monoxide is produced as the result of incomplete combustion of the fuel. Whilst most realised that nitrogen monoxide uses oxygen and nitrogen from the air some thought that at least one of these was in some way present in the fuel.

(b) (i) Most candidates correctly completed the equation.
(ii) This proved challenging with a large number writing $2O_3 \rightarrow 3O_2$ rather than actually using the equations as given.
(iii) Most candidates recognised the function of uv light but many suggested that it was chorine itself, rather than CFCs, that was involved in the homolytic fission reaction.
(iv) Whilst a large number of answers were specific and quoted the increased risk of skin cancer on exposure to uv radiation, weaker candidates were clearly confused and effects based on global warming were not uncommon.

2) (a) (i) To gain credit for this part, it was necessary to recognise that bond breaking was involved. Some candidates showed their lack of understanding when they quoted bond making or both breaking and making.
(ii) Since this is a standard definition, it was disappointing how many candidates omitted reference to 1 mole or broke the bonds in 1 mole of substance.
(iii) The calculation was generally well done with only a minority of candidates reversing the signs of the enthalpy changes needed for breaking and making the bonds. {*Numerical answer:* $-689\ kJ\ mol^{-1}$}

(iv) This is an example where candidates saw a statement about differences between enthalpy change values and related this to some sort of experimental error rather than actually considering the sources of the values being compared.

(b) (i) The use of le Chatelier's principle is an important concept in this unit and most candidates clearly understood it and were able to apply it to the example given. Very few examples were therefore seen when the rate of attainment of the equilibrium was confused with the equilibrium position.
(ii) Most candidates correctly related the increase in rate to an increased number of collisions with very few trying to alter activation energy.
(iii) Apart from a few who suggested specific metals or who confused heterogeneous with heterolytic or heterozygous, this was well known.
(iv) Most candidates were able to quote that the use of a catalyst would not alter the equilibrium position but significantly less actually explained why.

3) (a) Although the question required candidates to use their knowledge of the effect of temperature on particle motion, to gain full credit it was necessary to examine critically the difference between an increased rate of collision and an increased rate of reaction. Some candidates read the question carefully and gave excellent explanations but many others apparently saw the words 'rate' and 'temperature' and merely gave a standard description of activation energy. This would allow them access to four of the available five marking points.

(b) (i) Most candidates labelled the axes in a recognisable manner but some were clearly confused with enthalpy profile diagrams whilst a small number omitted the labelling completely.
(ii) On previous occasions candidates have often been required to draw the distribution at a higher temperature. A number appeared to read the question in this way. Although only a sketch was needed, so that credit was given if the curve was to the left of and higher than the original, candidates would be advised to be careful when completing their sketch. Credit was not given when their line crossed either the x axis or the line for T_1 at high energy values.

4) (a) (i) As with the previous definition, a significant number of answers were seen that omitted 1 mole or that the compound was formed from its elements.
(ii) Many correct equations were given with only a few starting from formulae other than elements. This error was seen occasionally even if the definition in (i) actually stated ' from the elements'.
(iii) Many numerically correct answers were seen and the best candidates explained clearly the way in which they reached their answer. For some weaker candidates, even those with a correct answer or one that was only incorrect in its sign, the method of calculation was less convincing. {*Numerical answer: 123 kJ mol*$^{-1}$}

(b) (i) Apart from a few who used pH ideas, this definition was well known.
(ii); (iii) This was another example in which many candidates apparently read the question as they were expecting it to be rather than using the information that was given. The vast majority of candidates therefore gave a correct equation for (iii) but large numbers suggested that 'fizzing' would be seen even though their equation did not show the formation of any gas.
(iv) The inclusion of a correct ionic equation remains almost exclusively a characteristic of a very able candidate.

2813/02 – How Far, How Fast? (Coursework)

General Comments

Centres generally coped well with the administrative burden of coursework and it was pleasing that the Moderators found this year that fewer adjustments than usual were necessary to ensure compatibility between candidates. This was particularly apparent with Centres tackling the option for the first time and it is greatly to the credit of those departments who took the trouble to attend meetings and understand the requirements of an unfamiliar scheme. There was some feeling that some more experienced Centres had begun to apply the criteria too liberally and without refreshing their memory of their precise nature: in these cases a word of caution may be necessary.

A very small number of Centres were still found to be using the original set of exemplar experiments and it may be necessary to repeat that use of the second edition of the Coursework Guidance is now obligatory.

Inevitably a number of issues arose and these are reviewed below.

There are still a number of Centres who are not using the proformas contained in the Coursework Guidance booklet and it is apparent that this is usually to the disadvantage of the Candidates.

Elsewhere there is only a little to add to the General Comments above. The recording of titration results is one area worthy of mention. Candidates cannot be awarded I7b in the lithium exemplar if initial burette readings have not been included and all results are to a consistent number of decimal places. To the nearest 0.05 cm^3 is preferred but precision to the nearest 0.1 cm^3 is accepted. In the same experiment the volume of gas collected should be to an integer number of cm^3.

Candidates tend to be careless in their use of units and, in particular, it is expected that the quotation of enthalpies should be in $kJ\ mol^{-1}$ and not $Kj\ mol^{-1}$.

When recording observations during the oxidation of ethanol, it is expected that the colour of the distillate will be included and described as colourless rather than clear.

Comments on Individual Skills

Skill P There is a need to emphasise that, for level 7 to be awarded, candidates should have provided instructions sufficient to allow the experiment to be performed exactly as described. Too often, Centres appeared to credit work which provided the background theory followed by an outline procedure but no detail. Centres are also reminded that P7a requires references to be accurate to at least the relevant chapter or, in the case of internet sites, to beyond the first slash ('/'). Occasionally Centres penalised candidates at P7a for the failure to evaluate the information obtained form their references but, if the experimental procedure subsequently described is reliable and accurate, it can normally be assumed that the evaluation has been done.

Skill I This was usually satisfactorily assessed but Centres sometimes gave marks too easily within the 'b' strands. At the higher levels, observations should be complete and accurate and readings should be tabulated in a clear format and to an appropriate level of precision. Correct units are essential.

Although a generous view was taken at moderation of the candidates' notes on potential hazards it is necessary to reiterate the point that was made last year. The precautions should be within the context of the experiment and relevant to the concentrations of reagents being used. Copying details from a 'Hazcard' is rarely suitable and leads to students to believe that acid which is an irritant at the concentration being used is corrosive. It should also be noted that it is sometimes the products of a reaction that are the cause for concern rather than the starting materials.

Skill A This skill is usually the most reliably assessed but there was some concern expressed by moderators that calculations were not always being checked sufficiently carefully to spot arithmetical mistakes. Some candidates created a smaller, but nonetheless significant, error by rounding numbers during the course of a calculation. Although the final answer should always be expressed to an appropriate number of significant figures, the full number of decimal places should be kept in the calculator until this point has been reached.

Skill E Marks tended to be lower for this skill which reflects its greater difficulty for candidates. There is no doubt that candidates need to be given extensive practice at evaluating experiments before an assessment is carried out. It is not a requirement that measurement errors should be expressed quantitatively but it may be wise to teach this as a matter of course. It is evident that Centres who use this approach aid their candidates in locating those measurements that have significant uncertainty.

The procedural errors identified must be inherent within the experimental method being followed and not related to carelessness in performing the task. For example, to state that a balance should be cleaned of any solid spilled on it previously should be part of normal laboratory practice and cannot be allowed as an improvement.

2813/03 – How Far? How Fast? (Practical Examination)

General Comments

There was an increased entry for the Practical Examination this year. The quality of scripts seen covered a wide range of ability.

Comments on Individual Questions

PLAN (A)

The quality of the majority of plans was very good, though there were somewhat fewer scoring full marks compared to other years.

Candidates were expected to use a crucible for the gravimetric experiment to determine $\boldsymbol{x}$ in $Na_2CO_3.\boldsymbol{x}H_2O$. Some candidates described this experiment very thoroughly, but others were content with very sketchy detail. Good answers included such details as the need to heat gently at first (though not, as a few candidates suggested, with a yellow flame) before having a few minutes of stronger heating. Candidates were expected to cool with a lid on, or in a desiccator, before weighing again. Brief comments about why such precautions are taken is also an advantage and these were often given by better candidates.

Specimen calculations are best presented using virtual figures, rather than an algebraic method or one that relies solely on words to attempt to explain. It is much easier for Examiners to see whether the candidate understands the stages in the calculation if figures are used, and therefore such answers normally score more marks. In this case candidates were expected to commence the calculation from readings that might have been obtained directly from their balance. Most candidates were aware of the need to heat to constant mass, though relatively few give a reason why this was necessary. Disappointingly, few candidates referred to the need to repeat the whole procedure to obtain consistent results.

The titration was generally described well. A few candidates chose an unsuitable indicator (phenolphthalein) and few got the indicator colour change the wrong way round. This year, Examiners were a little stricter in awarding the mark for stating the need for consistency of the titres: candidates were expected to make it clear that only accurate titrations would be included in calculation of the mean. A number of candidate wasted marks by presenting a specimen calculation showing how the number of moles of water of crystallisation could be calculated, whereas the question set required candidates to justify the quantities of chemicals to use in the procedure.

When discussing safety, candidates are expected to select information that is relevant to the procedure being described. Too many candidates rely on a ‘grapeshot’ approach, by quoting large amounts of information, much of which has nothing to do with the experiment being described. Candidates are penalised for over-stating the hazard of chemicals used: for example, dilute hydrochloric acid is not corrosive.

TEST (B)

Part 1 + Part 2

The standard of accuracy of measurements of temperature rise/fall throughout the Test was very high. As usual, the accuracy was assessed by comparison with the Supervisor’s submitted results. There were a few cases when Examiners had cause to suspect the validity of the Supervisor’s data and this inevitably led to their candidates being disadvantaged. There were a few Centres that did not supply to candidates the precise masses of materials that were specified in the INST (Confidential Instructions). Again this is likely to result in lower accuracy marks for candidates. A number of candidates lost marks by quoting too many or too few significant figures for accuracy of readings. All weighings should normally be quoted to two

decimal places and thermometers read to the nearest 0.5 ^{o}C.
It was pleasing that the majority of candidates were able to perform the calculations of enthalpy changes correctly. Inappropriate use of significant figures was sometimes the cause of loss of a mark: three significant figures should normally be quoted when giving answers to all calculations. Most candidates scored high marks on Parts 1 and 2.

Part 3 Application of Hess' Law proved more testing and only the most able candidates were able to score the three marks available. Most weaker candidates were unable even to draw both arrows in the correct (downward) direction. In questions about safety, candidates are often expected to refer to hazard information supplied on the question paper. Reference to **plenty** of water for washing spills of corrosive materials was also required.

Part 4 Most candidates answered well on (a), although few scored the mark available for referring to an increased **frequency** of collisions.
When answering (b), weaker candidates often discussed ideas related to poor technique (such as solid getting stuck to the side of the cup or failure to notice the maximum/minimum temperature on the thermometer). These ideas do not score any marks. Heat losses/gains, loss of materials due to frothing and significant percentage errors in the thermometer readings were among correct ideas that were credited. It is encouraging to note that more candidates are being taught to calculate percentage errors when standard items of equipment are used.
Answers to (d) were generally poor. It appeared that many candidates had never actually added small quantities of water to an anhydrous compound. Many thought that water would not react with anhydrous sodium carbonate at all or, if so, very slowly. Many different responses to this question were credited. Some candidates referred to the difficulty of measuring the temperature of solid materials, others to the fact that the very exothermic reaction would result in evaporation of water. Some candidates made use of research for their Plan about the different hydration states possible for sodium carbonate, while a few good candidates were aware that, if excess water was used, the product would dissolve thereby adding an 'extra' enthalpy change to the process under investigation.

2814 – Chains, Rings and Spectroscopy

General Comments

This paper produced a good range of marks and discriminated well. Nearly all the candidates appeared to have enough time to complete the paper. As with the January paper, it was designed to be a little harder than those in previous years. This reflects the higher standard of A2 compared to AS. Some candidates therefore found the exam quite challenging, but it was good to see many able to apply their knowledge and understanding of organic chemistry to good effect. It was particularly pleasing to see how many candidates had a very good knowledge of the reactions tested, with most also able to write correct chemical equations. Confidence with n.m.r. spectroscopy is also improving with each paper, and teachers deserve credit for their effective teaching of this topic. Candidates do however still struggle with accurately drawing the three-dimensional shape of the bonds around a tetrahedral carbon. The use of 'wedge' and 'dotty' bonds to represent bonds out and into the plane of the drawing does need practice. This was particularly evident in question 6(d), which required 3-D diagrams to distinguish between atactic and syndiotactic poly(propene).

Comments on Individual Questions

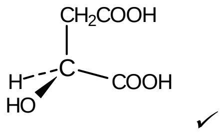
1) (a) Most candidates knew the general formula of an α-amino acid and there were few who were confusing it with the type of general formula used to represent an homologous series. Many could also successfully interpret the structural formula of leucine given.

(b) A significant number of candidates tried to define a zwitterion in terms of the proton transfer process (as was required in part (ii) of this question). For the definition, it needs to be clear that both positive and negative charges are on the same molecule.

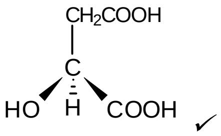
(c) Conditions for the hydrolysis of a protein were well known, with a suitable named aqueous acid, base or enzyme being accepted. Dehydrating acids such as concentrated sulphuric acid are not suitable for hydrolysis.

(d) The use of ethanolic ammonia to substitute a chlorine atom by the amine group was not well known. This is one of a number of reactions that have been added to this specification for assessment from this year and teachers should ensure that they are using the Revised Edition of the specification for teaching from September 2004. Many candidates identified that an amino acid from a natural source such as meat would only contain one of the two possible optical isomers, whereas the laboratory synthesised sample would contain both. Candidates should avoid unclear statements for the two different isomers such as 'the laboratory sample contains optical isomers'.

2 (a) Almost all candidates correctly identified the chiral centre in the given malic acid structure. For the 3-D structure of the molecule, the two structures shown below were acceptable.



or



(b) Many candidates correctly identified the molecular ion peak on the malic acid spectrum and were also able to deduce that the *m*/*e* value of lactic acid would be equal to its relative molecular mass.

(c) This part gave more able candidates the opportunity to demonstrate their understanding of n.m.r. spectroscopy by predicting splitting patterns and relative peak areas for lactic acid in D_2O. Many other candidates did however gain some marks by correctly showing either the splitting patterns or the areas correct. A significant number of candidates thought that only one extra peak would appear without D_2O and did not allow for both alcohol and carboxylic acid OH groups.

(d) This part was well answered. To gain the mark for part (ii), candidates needed only to relate some sort of flavour change to the presence of the ester or the lowering of the acid content.

3) (a) The reaction of phenol with sodium or sodium hydroxide and the associated equation was very well known.

(b) A pleasing number of candidates were not put off by the unfamiliar context for the electrophilic substitution mechanism and applied their understanding of the ability of the C=O group to receive an electron pair to identify positions of the dipoles and ‘curly arrows’ correctly. The explanation for the activation of the benzene ring by the phenoxide was well explained by some candidates. However, there are still some who do not identify the role of the lone pair of electrons from the oxygen in increasing the π-electron (negative charge) density around the ring, making it more attractive to electrophiles.

(c) This calculation was typical of the less structured calculations found on A2 papers. Only more able candidates obtained the correct answer of 5298 tonnes (or 5300 tonnes if the answer was rounded to allow for a minimum of two significant figures in the data). In some cases, candidates lost a mark through a rounding error and teachers should remind candidates not to round their answer until the final stage. Errors were carried forward throughout the calculation to allow partial marks to be obtained.

4) (a) The manufacture of azo dyes is better known and there were fewer candidates who had not learnt this synthesis than in previous years. For the displayed structure of the diazonium ion, the positive charge does need to be on the correct nitrogen atom. There are two correct (resonant) forms that are acceptable, shown below.

$-\overset{+}{N}\equiv N$ or $-N=\overset{+}{N}$

(b) Many candidates scored high marks on this part and clearly knew the chemistry of these reactions well. The alkylation of the benzene ring could be carried out at any stage although candidates did need to be consistent with their chosen steps and intermediate compounds. Some candidates attempted to give mechanisms when only overall equations were required. Knowing the distinction between these will save candidates time in the examination.

5) (a) Many candidates coped well with the skeletal formulae of unfamiliar compounds in this question and demonstrated their ability to apply their knowledge of the relevant functional groups. Some candidates struggled with naming the secondary alcohol even though the ketone above had much of the name in common. The structure of the acyl chloride was also not well known. This functional group and its formation using $SOCl_2$ are also in the content added to the specification for A2 assessment from year.

(b) A pleasing number of candidates drew the correct addition polymer formed from pent-3-enoic acid. Some realised that the methyl and ethanoic acid groups would form side chains, but lost a mark through simple valency errors. It is important that candidates are taught to look out for these, particularly when converting from skeletal to displayed formulae.

(c) A good number of candidates deduced the correct molecular formula for the ester from its skeletal formula and could construct a balanced equation for its combustion. Any reference to the extra oxygen in the ester or to the need to decrease the amount of incomplete combustion was acceptable as a suggestion for the role of the ester in reducing the amount of soot.

(d) Again, many knew that heating under reflux with aqueous sodium hydroxide would effectively hydrolyse the ester group in the molecule. When a reagent is asked for, less specific terms such as ‘alkali’ may not earn full credit. We need to know what the substance the candidate would actually use. Name or correct formulae are always acceptable.

6) (a) This part caused problems for a significant number of candidates.
In part (i), the wording in the question was unclear and all candidates were credited with the mark, whether or not they had attempted the question.
Part (ii) asked candidates to draw the repeat unit of Terylene and to describe how it is formed from its monomers.
There were a number of comments from Centres taking issue that the question went beyond the assessment outcomes in the specification. It is acknowledged that the specification does have some ambiguity and that it may not have been appropriate to ask for the repeat unit of Terylene without supplying its monomers. In the future, such information will be provided.
This was considered carefully when the mark scheme for the examination was applied so that candidates would not be disadvantaged.
The mark scheme was further relaxed for part 6(b) to allow a candidate to score full marks without needing to know the structure of Terylene.
All issues were considered carefully at the Awarding meeting and grade boundaries were chosen to take account of candidates who did not know the structure of Terylene.

(b) A good number of candidates correctly deduced that neither polymer could be cellulose, as neither contained the broad O–H stretch at 3230–3550 cm^{-1} expected for alcohols. R was therefore most likely to be a hydrocarbon, as it contained none of the absorptions for the C=O, O–H or C–O bonds, whereas P contained both C=O and C–O bonds. A significant number of candidates did however mistake the small absorption at around 2900 cm^{-1} for an O–H bond in a carboxylic acid. This would have given a much larger and broader peak covering a much wider range. Teachers might usefully advise candidates in future that other small sharp peaks can occur within the range given in the *Data Sheet* for carboxylic acid O–H bonds.

(c) Many candidates knew that poly(phenylethene) was a common hydrocarbon polymer used in packaging, although PVC was a common incorrect answer.

(d) Many candidates knew that the side chains alternated for syndiotactic and were somehow randomly arranged for atactic. However, a significant number of the diagrams did not show how this effect is due to the 3-D arrangement around the tetrahedral carbons. Diagrams could be displayed or skeletal, but the use of 3-D bonds is essential here. Some simply drew a non 3-D displayed formula. Other candidates thought that atactic meant that the side chains occurred at random positions along the chain rather than on every other carbon. This is an area of the specification that would benefit a little more time spent practising the diagrams.

7) This question gave candidates the opportunity to apply their knowledge and understanding of the nucleophilic addition mechanism to explain why nucleophiles rather than electrophiles react with the carbonyl group. Many candidates had a good attempt at the question and knew the details of the mechanism. A number of candidates did not describe the π-bond in terms of p-orbital overlap to give the bond above and below the plane of the molecule, although more correctly identified the partial positive charge on the carbon as the reason that nucleophiles were attracted to the group.

2815/01 – Trends and Patterns

General Comments

This examination paper produced an excellent distribution of marks from 0 to 45. The mean mark for the paper was 25.

There was no evidence that candidates did not have sufficient time to finish the paper. The candidates often found the quantitative questions more accessible than the qualitative ones. As a result candidates with poor overall marks often scored maximum marks on the calculations but then made little or no attempt on Q.5 which focussed on the chemistry of iron.

As in previous examinations many candidates did not use terms such as atom, molecule and ion with any precision.

Comments on Individual Questions

1) This question focussed on lattice enthalpy and the Born-Haber cycle. Candidates from the whole of the ability range were able to access the questions and even the weakest candidates often scored at least four marks.

   (a) Many candidates were able to complete the Born-Haber cycle using the appropriate enthalpy changes. A significant proportion only scored two marks since they did not double the first ionisation energy of sodium and the enthalpy change of atomisation of sodium.

   (b) Candidates gained full marks for the correct lattice enthalpy of –2521 kJ mol^{-1} or for a value that was an error carried forward from their enthalpy changes in the Born-Haber cycle in Q.1(a). The most frequent error that was carried forward was –1917 kJ mol^{-1}. A common misconception was to use the negative value for the enthalpy change of formation *i.e.* +416 rather than –416. Good answers were exemplified by clear working out that allowed the Examiner to see any error carried forward.

   (c) Most candidates selected calcium chloride in Q.1(c) and then gave an explanation based on the difference between anionic radius and cationic charge. Many candidates referred to the wrong particles or did not specify a type of particle at all in Q.1(c). Typical incorrect statements referred to the charge of calcium rather than the calcium ion or referred to the difference in the atomic radii rather than the ionic radii. The use of the wrong particle was only penalised once in this question.
   Common misconceptions included using the difference in electronegativity of the halogens and the reactivity of the metals to explain differences in lattice enthalpies. Other candidates referred to polarisation which was ignored.

2) This was a short question about brass, copper and zinc. Candidates found the calculation in Q.2(c) more demanding than the other two part questions.

   (a) A smaller proportion of candidates than in previous examination papers wrote incorrect electronic configurations for transition metal ions. Almost without exception candidates could explain why copper is a transition element and zinc is not.

(b) The mark scheme demanded a comment about compounds of Cu^{2+} and a comparison with compounds of Zn^{2+}. It was not sufficient just to state that copper salts are coloured. Candidates made comparisons about the colour, possible catalytic properties and complex formation. Since the specification makes no reference to the chemistry of Zn^{2+} candidates were allowed to state that this ion would not form complexes. A common misconception was to refer to Cu^{2+} having varying oxidation states.

(c) Many candidates were able to calculate the number of moles of hydrogen produced although a frequent misconception was to half this value to get the moles of zinc. A significant proportion of the candidates correctly worked out the mass of zinc but a small number of candidates used the relative atomic mass for copper instead of that for zinc. Only the most able candidates realised that they had to subtract this mass from the total mass to get the mass of copper. The mark scheme gave full marks for answers between 82.9 and 83.2 provided they had three or four significant figures. The majority of candidates quoted answers to the correct number of significant figures.

3) This question proved to be quite demanding and many candidates only scored one or two marks out of the five available.

(a) In (i) most candidates wrote the correct half equation. The mark scheme allowed an equilibrium sign, $Cu \rightarrow Cu^{2+} + 2e^-$, or $Cu - 2e^- \rightarrow Cu^{2+}$.
The most common misconception was to put the electrons on the left hand side *i.e.* $Cu + 2e^- \rightarrow Cu^{2+}$.
In (ii), the full redox equation was often correct but there were often errors of omission, *e.g*. having only one Cu rather than two.

The calculation of the value of *x* was very demanding. The majority of candidates were not able to work out the relative formula mass for $[(CH_3COO)_2Cu]_2.Cu(OH)_2$. A frequent answer was 478.5 which included some water. Without this relative formula mass it was impossible to gain full marks. Many candidates calculated 16.3% of this relative formula mass and used this number to estimate *x*. This was not given any credit.
The most able candidates either:

- calculated the relative formula mass of verdigris and used this to work out *x*
- solved the equation $[18x/(460.5 + 18x)] \times 100 = 16.3$
- worked out the molar ratio for $[(CH_3COO)_2Cu]_2.Cu(OH)_2$ and of water

Only a very few candidates tried trial and error.
The answer of 5 was only given full marks if supported by adequate working out.

4) This question focussed on the chemistry of oxides of elements in Period 3.

(a) Although most candidates drew the correct 'dot-and-cross' diagram for Na_2O there was still a significant proportion that drew a covalent diagram. Candidates need to be careful that they draw $2Na^+$ rather than Na_2^+.

(b) A large proportion described the strong electrostatic attraction between magnesium and oxide ions however a small but significant proportion did not use the correct terminology and mentioned molecules and strong intermolecular forces.

Most candidates stated that when magnesium oxide is added to water it makes magnesium hydroxide but fewer candidates were able to state the correct pH of the solution.
In (iii), only a very small proportion of the candidates were able to give the accepted ionic equation. Candidates were expected to use MgO(s) as stated in the question and not to include any spectator ions. Many candidates did not include ions at all.

(c) Although the majority of candidates could write the equation to make aluminium oxide, a common misconception was that aluminium oxide had the formula Al_2O_6.

(d) Many candidates could give two physical properties for silicon(IV) oxide. The most frequent correct answers were hard, high melting or boiling point, poor electrical conductor and insoluble in water. Silicon(IV) oxide is a solid was not accepted unless qualified by reference to the high melting point.

(e) Weaker candidates often gave a physical property rather than a chemical property. The most frequent correct answers were it reacts with water to form an acid or that is an oxidising agent. A small proportion of candidates just referred to a reaction with water without mentioning that an acid was formed.

(f) Almost all candidates could describe the reaction of sodium with water, although fewer candidates could identify the products formed. A significant proportion of candidates stated that magnesium oxide rather than magnesium hydroxide was formed with magnesium and acid. The majority of candidates described the difference in the rate of reaction between sodium and magnesium to gain the second marking point. Candidates also scored this marking point if they compared the pH of the aqueous solution formed after reaction.

5) This question focussed on the chemistry of iron. It also included one mark for the quality of spelling, punctuation and grammar. For this question one mark was awarded for an answer that addressed the question and included two sentences with correct punctuation and grammar. Most candidates scored this mark even if they scored no other marks.
A small but significant proportion of candidates made no attempt to answer this question while other candidates just focused on one type of reaction.
Good answers were typified by a clear and organised answer that focussed on each type of reaction in turn. Weaker answers often gave lots of superfluous information such as the shape of complex ions and the bonding within complex ions.
The specification only refers to one ligand substitution reaction involving $Fe^{3+}(aq)$ namely the reaction with SCN^- to make $[Fe(H_2O)_5SCN]^{2+}$, however a significant number of candidates gave incorrect answers based upon the chemistry of Cu^{2+} such as ammine formation by $Fe^{2+}(aq)$. A common misconception was to use $[Fe(H_2O)]_6]^{2+}$ rather than $[Fe(H_2O)_6]^{3+}$ in the thiocyanate ligand substitution reaction. A small fraction of candidates used this reaction as an example of redox.
Most candidates who attempted to write about precipitation gave reactions of aqueous iron(II) ion or aqueous iron(III) ion with aqueous sodium hydroxide or aqueous ammonia. Candidates often wrote the correct ionic equation and although state symbols were not required they were often included. A small but significant proportion gave the precipitate an aqueous state symbol. A small fraction of candidates had the misconception that iron(II) ions or iron(III) ions reacts with water to give the corresponding hydroxides.
Candidates gave a wide range of redox reactions including iron with hydrochloric acid, rusting, displacement reactions with iron, oxidation of iron(II)

ions with acidified manganate(VII) ions. Candidates with a correct redox example often gave the correct equation. A significant proportion explained the redox reactions with the aid of oxidation numbers although this was not needed in the mark scheme

2815/02 – Biochemistry

General Comments

The paper proved to be more approachable than some of its recent predecessors and candidates scored higher marks on average. At all levels of ability there were sound responses particularly on the competitive inhibition of enzymes and on the structure of DNA and transcription. Carbohydrate chemistry, as usual, caused problems for weaker candidates. Most scored the Quality of Written Communication mark for their use of technical terms; sadly many went on to lose marks elsewhere in the paper due to poor expression of their answers.

Comments on Individual Questions

1) (a) (i) This was almost universally well done. A small minority of N–H…..N bonds was seen.
(ii) Almost all candidates knew the types of secondary structure of proteins.

(b) (i) The great majority were successful with this preliminary question on tertiary structure.
(ii) Most recognised that the repulsion would be electrostatic, but did not convey the idea of opposite charges. The commonest mistake was to refer to mutual repulsion by non-bonded pairs of electrons.
(iii) There were some excellent answers, which correctly implicated the protonation of COO^- at low pH or the deprotonation of NH_3^+ in the break down of ionic attractions. Weaker candidates were confused in their arguments, which often would have lead to the creation of more opportunities for attraction, not less. Starting incorrectly from COOH and NH_2 at pH 7 was the underlying problem.

(c) Many answers mentioned the tertiary structure of proteins, often with detail of the attractions maintaining it, but did not clearly refer to the shape of the active site. A number of candidates tried to use the term ‘specific’ as the reason for the specificity. Better answers emphasised the importance of R groups in binding substrate and assisting catalysis, and the importance of induced fit. The mark for Quality or Written Communication was usually awarded for the correct use of technical terms.

(d) The best candidates had no difficulty with this. Any dipeptide of correct molecular formula was accepted provided it showed two α–amino acids linked with an amide (peptide) link. Many answers had incorrect molecular formulae or used β-amino acids.

2) (a) An acceptable drawing was given by most candidates, with only a very few drawing a micelle instead of a bimolecular layer.

(b) Most candidates were able to draw glycerol, and to make the connection between that and phosphate. A good number also drew an ester link between glycerol and stearic acid. Only the best made the choline connection, several looking for an ionic attachment to the negative oxygen on phosphate.

(c) About half the entry scored full marks on this question about competitive inhibition, not being in the least bit put off by the unfamiliar reaction. Most drew the expected graph, although some lost a mark by labelling the *x* axis as time, in spite of the instructions given in the question. Others drew the correct graph, but then implied in their discussion that time was a factor in 'getting back to V_{max}'. The reversibility of inhibitor–enzyme binding was not often mentioned.

(d) There were some excellent answers, which showed that the candidates had a clear understanding of the connection between van der Waals' attraction and the long hydrocarbon chains found in both lipids. Weaker candidates seemed to be misled by the polar heads and tried ionic attraction or, inevitably, hydrogen bonding.

3) This question was well done by the great majority of candidates, particularly providing a lifeline for the weak.

(a) (i) Some candidates did not look at the mark allocation and discussed the sugar or the base but not both.
(ii) All successfully indicated one of the carbonyl groups as a hydrogen bonding site, but very few thought of the NH group between them. Instead they suggested both carbonyl groups.

(b) (i)This mark was scored by nearly everybody. The numbering of the candidates' sequences, if given, was ignored in the marking.
(ii) Candidates who structured their responses scored highly. They will have included the ideas of complementary base triplets on m-RNA and t-RNA and the hydrogen bonding that draws them together. Far too many candidates instead referred only to codons and anticodons, sometimes back to front, and did not mention the hydrogen bonding or formation of a new peptide link at all.

4) This turned out to be the most difficult question on the paper, particularly so for those who had not learnt about polysaccharides. There were several blank spaces and zero scores.

(a) Most scored a mark for indicating the whereabouts of a 1,4 and a 1,6 link, though several labelled the C5 carbon as C6. The mark allocated for correct stereochemistry (α at both) was much more elusive and many candidates omitted this.

(b) Many candidates only gave one method rather than two (enzyme **and** acid-catalysed hydrolysis). Both plain water and alkali were quite frequent responses.

(c) Full marks were common for the most able candidates who not only knew the functions and properties of amylopectin but were able to relate these as required by the question. Weaker candidates were frequently vague in their responses.

(d) (i) This was generally well done, but some candidates did not score because they left out one or more of the required bits of information in their answer. The many OH groups in glucose are able to form hydrogen bonds to water.
(ii) The better candidates were able to score one mark by discussing either glycosidic links or internal hydrogen bonding as tying up many of the OH groups. Few were awarded both marks.

2815/03 – Environmental Chemistry

General Comments

A full range of marks was seen from the small entry, but only the best candidates were able to show competence in all sections of the specification. The chemistry of clays was not well known. Some equations were correctly written by most candidates, particularly those relating to CFCs, although equations for hard water reactions proved elusive. Most candidates scored the Quality of Written Communication mark for the use of scientific terms, but too many went on to lose marks elsewhere because of poor expression of their ideas.

Comments on Individual Questions

1) (a) Many candidates at all levels of ability made a weak start by apparently ignoring the stem of the question, which tied the responses to waste disposal.

(b) This was well done, the majority of candidates scoring at least one mark.

(c) (i) Toxic or poisonous was required, rather than harmful.
(ii) Better candidates suggested van der Waals' attraction, but many tried hydrogen bonding.
(iii) Nearly all candidates were credited for photosynthesis.

2) (a) (i) For many candidates this question provided a lifeline. Most recalled the role of UV radiation in the generation of chlorine free radicals, and the subsequent reaction of these with ozone. Only the best candidates recognised the importance of oxygen atoms in continuing the chain reaction. Few others were able to suggest sensible alternatives.
(ii) Most knew that hydrofluorocarbons are broken down in the troposphere, but few gave a reason for this.

(b) (i) Direct combination of the elements at high temperature was the required answer, but most candidates gave only half the answer. Car exhausts did not score.
(ii) Most were successful here. Those that were not failed to cancel the N_2O_2 on each side of their equation.
(iii) Most correctly wrote +2. The commonest wrong answer was +4, presumably meaning +4 for the two atoms together.

(c) Most candidates mentioned ozone depletion (stratosphere) or photochemical smog (troposphere); some got both.

3) (a) (i) Correct answers were rare, even given the broad hint in the stem. Many candidates seemed to have no idea what was required.
(ii) This equation was better known, the reaction being the standard hardness of water.

(b) The removal of Ca^{2+}(aq) by ion exchange was known by half the entry. The other half either wrote in vague terms, or tried to go round the problem by boiling the water or adding sodium carbonate to it.

(c) The use of chlorine was well known, but only the better candidates were able to explain the chemical principles of flocculation.

(d) Many candidates scored on this question, despite the daunting diagram, being able to relate acid rain to low pH and, hence, to low concentration of hydrogencarbonate ions. Weak candidates thought that acid rain led to high pH, or suggested that the acid rain was due to an increased concentration of dissolved carbon dioxide.
Many candidates thought that hydrogencarbonate ions were involved in precipitation of calcium carbonate.

4) The question was well answered by the few who knew their clay chemistry, but there were many poor responses and some complete blanks.

(a) Many candidates drew diagrams showing the use of two rather than three corners of the silicate tetrahedron.

(b) Only the best candidates knew that sheets **within** a layer are linked by the sharing of the fourth oxygen atoms on silicate units with a neighbouring aluminate unit.

(c) This proved to be the most accessible part of question 4. Candidates knew that hydrogen bonding holds the layers together, leaving insufficient room for water or hydrated cations to enter. That the hydrogen bonding was between O on a silicate sheet and OH on an aluminate sheet was less well known.

(d) Many of those attempting this part knew that the swapping of Al^{3+} for Si^{4+}, or of Mg^{2+} for Al^{3+}, generates negative charge which attracts cations, allowing ion exchange with the soil solution. Several thought that this swapping was the ion exchange referred to.

(e) The majority of candidates scored one mark for balancing an equation which included $CaCO_3$ rather than $Ca(HCO_3)_2$ for temporary hard water.

2815/04 – Methods of Analysis and Detection

General Comments

Many candidates were very well prepared for this module and had gained a very good understanding of this area of chemistry.

Candidates were able to deduce chemical structures from spectra of various types very well. Able Candidates lost marks mostly through imprecise language or lack of detail. Many of the candidates showed very good understanding of the concepts and wrote logically in responses demanding explanations.

Comments on Individual Questions

1) This question was very well answered by the majority of candidates. (a) (i) caused some candidates to lose marks through imprecise use of the word neutral rather than a description of overall net charge of zero.
Part (b) was well answered. Some candidates knew that hydrogen ions needed to be added to the buffer but described this as raising the pH. The general structure of an amino acid or its zwitterion was acceptable.

2) (a) (i) The electrons must be excited; a significant number of atoms were excited in candidates' responses and this is an example of imprecise language causing candidates to lose marks.
(ii) A significant number of candidates tried to describe the significance of the convergence limit in terms of the removal of the electron, rather than why the lines converge.
(iii) It was evident that most candidates had carried out this calculation before and many correct answers were seen. Many candidates failed to change J to kJ and even more did not give the final answer to the correct number of significant figures.

(b) (i) This was well answered apart from the first type of 'electronic'. Many candidates wrote 'mass' or 'emission'.
(ii) Candidates did not always realise what the question was really asking. Some good answers were seen based on quantisation and others clearly showed awareness of different entities somehow being linked to different frequencies. The latter often produced a rather vague response.

3) (a) A lot of candidates used the expected formula linking M and M+1. A significant number also used the data in addition to an A_r technique. A significant minority ignored 1.1 and calculated 21 or 22 carbons.

(b) (i) The most common incorrect answer was to give the answer to (ii) in (i).
(ii) Although many correct answers were seen, candidates seemed quite convinced that all questions involving chromophores must include benzene! Candidates of all abilities lost a mark for omitting to say it was the lone pair on the oxygen that mattered and just referred to the O or OH.
(c) Most candidates gained 2 marks here.
(d) (i) Most candidates correctly interpreted the data to comment on at least one of the 'distance between O's' or the 'length of conjugation' effect.

(ii) Most candidates understood the significance of this question but some were unable to express their answers well. A small number thought that they somehow had to extend the range at which the rhodonines would absorb by having further structure with the oxygen atoms further apart or closer together.

4) This question was high scoring for the full range of ability of candidates.

(a) A significant minority ignored the instruction to 'use the data' and, even though they deduced the molecular formula, they then lost this mark.

(b) The two marks for interpreting the IR spectrum were almost without exception scored.
The approach to the use of n.m.r. was very wide across the spread of candidates, but most tackled this question in a logical manner. Candidates who offered alternatives for each peak did not score those marks.
Some candidates who used the chemistry well did not score the mark for Quality of Written Communication because they did not use the correct language e.g. 'split into three' instead of 'a triplet'.

(c) This scored highly. A few candidates forgot the charge on the fragment ions but even more did not actually write down the relevant m/e.

2815/05 – Gases, Liquids and Solids

General Comments

Most candidates for this paper were well prepared and showed a good understanding of the specification for this unit. They were able to answer longer questions in a logical way and were also able to set out calculations in a clear manner. Marks were most commonly lost by candidates being casual in their expression of technical terms or by candidates not answering the exact question being asked and instead answering a question that they expected or had prepared for.

Comments on Individual Questions

1) This question was very well answered by the majority of candidates.

   (a) Candidates were able to clearly identify the basic assumptions about ideal gases.

   (b) (i) Candidates were able to describe collisions accurately.
   (ii) Candidates had practiced this type of calculation and most were able to substitute into the equation given, including for the number of moles. Errors were common in the use of powers of 10 and in converting from for example grams to kilograms.

   (c) Most candidates were able to identify the basic assumptions that no longer apply under both low temperature and high pressure.

2) This question was well answered by the majority of candidates.

   (a) The majority of candidates were able to identify the pressure reducing as the cause of bubbles.
   However a significant number described this as the pressure being released and so did not score the first mark. Significantly fewer candidates were able to link the reduction in pressure to a reduced solubility of the gas.

   (b) This question was very well answered by the vast majority of candidates.

   (c) This calculation was very well done. Some candidates forgot to multiply by two.

   (d) This question was extremely well answered. By the majority of candidates.

3) This question was not answered as well as would be expected, mainly due to lack of detail in candidates' responses.

   (a) (i); (ii) Despite being given a lot of information about this lead/tin mixture, a significant number of candidates were very vague about what was cooling where! It was clear that many of these candidates did not read the information and answered in general terms about a cooling curve for any mixture. Candidates should be aware that information at the start of a question such as this is relevant and will help them to answer in the precise terms that are required for this standard.

(b) This diagram was drawn very well by many candidates. Those who failed to score full marks were mostly those who ignored the instructions to label the areas and to indicate significant temperatures.

4) This question was accessible to all candidates although many candidates were imprecise in their use of technical language and/or lacked detail in their answers.

(a) (i) A large proportion of candidates made this question into ‘why do we separate crude oil into fractions’ and so answered in terms of the use of each fraction, rather than refer to the chemistry of a mixture of different boiling points that allows fractional distillation to be used to separate these fractions.
(ii) This question scored well for many candidates, although even the most able candidates used language more appropriate to GCSE than an A Level discussion of a fractionating column. Very few candidates even attempted to include a description of the equilibrium established on the plates and as a result did not score full marks.

(b) (i) This question was well answered. A common omission was the vapour pressure of the pure component, with answers such as ‘proportional to mole fraction’ therefore only scoring one mark.
(ii) A surprising number of candidates found this calculation difficult and were unable to use the phrase ‘equal amounts in moles’ as a number in their calculation.

(c) (i) Very few candidates were able to draw a curve with a definite maximum. The liquid curve was not required to gain the mark. Some candidates labelled the axes as boiling point and composition despite the question stating that the curve should be for vapour pressure and composition.
(ii) Many candidates were able to explain a positive deviation accurately.

(d) The majority of candidates identified the different intermolecular bonds in these two compounds as the significant factor in boiling point. Many candidates did not refer to these bonds being broken in order for the liquid to boil and so did not score the second mark.

2815/06 – Transition Elements

General Comments

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

A majority of scripts were clearly legible and the use of diagrams, when required, was encouraging. 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.

Once again, quantitative chemistry was a real problem for many candidates. The ability to formulate redox equations also seems to be a concept beyond all but the most able.

Comments on Individual Questions

Q1 (a) This should have been an easy start to the paper but many candidates simply used the words ‘electrode potential’ in the definition, rather than the expected ‘voltage’ or ‘emf’. Standard conditions were often not given.

(b) This was generally well answered but a few candidates missed out the salt bridge and a number had electrons flowing from silver to copper. On the point of electron flow, candidates should indicate this on the wire between the electrodes. Too many candidates put an arrow somewhere between the wire and the salt bridge.

(c) This is a difficult concept. Good candidates had no problem with this but weaker candidates tended to discuss larger or smaller electrode potentials without referring to oxidation or reduction. There were too many statements such as ‘iodine is oxidised by iron’. Clearly weaker students do not fully understand the concept of electrode potential.

Q2 (a) A surprising number of candidates included $4s^2$ in the electron configuration of the Ni^{2+} ion.

(b) Candidates are improving in their interpretation of visible spectra but many thought that this complex was purple often despite having already stated that red was absorbed.

(c) The nitrogen atom was often not recognised as an atom capable of forming a dative covalent bond.

Q3 (a) Many candidates described, incorrectly, that co-ordination number is the number of ligands attached, rather than the number of coordinate bonds. Many gave the shape of platinum complexes as tetrahedral.

(b) There were some very interesting values for x and y.

(c) Many candidates drew tetrahedral structures here but then used the structure to describe *cis-trans* isomerism. The use of *cis*-platin as a treatment for cancer is well known.

Q4 (a) Although many candidates knew the sequence of colours for the reduction of VO_3^- to V^{2+}, the actual formula for the +4 oxidation state ion was often not known.

(b) Despite being given volumetric data, many candidates answered this question using oxidation numbers only. Such answers were not credited. Only the best candidates obtained full marks for this part. Weaker candidates were able to work out the number of moles of MnO_4^- and VO_3^- but could not then make the link between these values and the number of electrons transferred.

(c) Only the most able candidates in selected centres were able to provide a correct, balanced equation for the oxidation of V^{2+} to VO_3^-. This would suggest that the skill of constructing redox equations from first principles is not prioritised in a many centres.

Q5 Generally, candidates were more familiar with the chemistry of cobalt(II) than cobalt(III). Candidates were often penalised for stating the colour of Co^{2+} rather than a specific complex, *e.g.* $[Co(H_2O)_6]^{2+}$ as pink; $[CoCl_4]^{2-}$ as blue. The colour of a cobalt (III) complex was less well known. Candidates were aware of the shapes of complexes and could draw 3-D diagrams for both octahedral and tetrahedral complexes.

Interestingly, many candidates gave an example of ligand substitution using $[Co(H_2O)_6]^{2+}$ and Cl^- which not only gave a change in colour and co-ordination number but also a change in oxidation state from +2 to +3, with the ion $[CoCl_4]^-$ being formed rather than $[CoCl_4]^{2-}$.

Good candidates had knowledge of the chemistry of cobalt(III). They clearly stated that $[Co(H_2O)_6]^{3+}$ was very unstable and knew that the ammonia ligand would stabilise the +3 complex. The best candidates illustrated this with a series of balanced equations involving the reaction of $[Co(H_2O)_6]^{2+}$ with aqueous ammonia and the subsequent oxidation by air or hydrogen peroxide. A few candidates even supported their answers using the actual $E^{\ominus}$ values!

2816/01 – Unifying Concepts in Chemistry

General Comments

Overall the performance of the candidates was slightly lower than those from last year. While the answers to some questions such as the calculation of the pH values in Q3 and the identification of adipic acid in Q5 were generally of a pleasingly high quality, other questions such as the discussion of the buffer solution were rather poorly handled. Worrying are the significant number of candidates who score reasonably well but who give the formula of magnesium chloride as MgCl or suggest that ammonia dissociates into H^+ and NH_2^- and, in so doing, reveal themselves to have a serious lack of chemical understanding. There was some evidence that candidates from some centres were unaware of the NH_3/NH_4^+ buffer system, despite it being clearly stated in the specification. This buffer system has been rarely tested in the past but this does not preclude its inclusion in an examination paper (as many candidates discovered at their cost this year).

Comments on Individual Questions

1) (a) This opening question was in general well answered with the majority of candidates expressing the idea of partial pressure, although sometimes rather awkwardly. Candidates should be encouraged to use the definition of the product of the partial pressure and the mole fraction, which was not used in the majority of answers.

(b) Again this was well answered. The most common error was to ratio the two partial pressures *i.e*. 3/85 rather than the ratio of the chlorine partial pressure to the total pressure: 3/88.

(c) (i) Most candidates gave a correct expression to this part and it was very pleasing to see that the occurrence of square brackets appeared much reduced in comparison to previous years.
(ii) In general this was well answered, although a number of candidates failed to round the calculated value properly to 0.106 and so gave an answer of 0.105. This is indeed a poor error to be made by a candidate at this level.

(d) A large number of candidates obtained one mark here by discussing the shift of the equilibrium position to the side with fewer gaseous molecules. Very few then went on to pick up the second mark by describing how such a shift would ameliorate the overall increase in pressure. The very best candidates discussed the changes in terms of maintaining a constant value for K_p.

(e) Many candidates described correctly the shift of the equilibrium position but far fewer linked this to the change in the value of K_p. There is a lesson here for candidates that they must not rush their answers but take time to explain the answer fully.

(f) This final part to the first question presented a number of pitfalls, one or more of which were fallen into by the majority of candidates. The first error was to fail to covert 1.6 million tonnes into grams, many calculations using 1.6×10^6 g or more surprisingly 1.6×10^{13} g. Most candidates did then divide by 71 although a small minority unexpectedly used 70 as the relative molecular mass of chlorine. The next serious error was to fail to note the stoichiometry of the reaction and so double the amount of chlorine. Finally, a significant number of weaker candidates then converted the amount of sodium chloride into a mass of NaCl rather than a volume. Of those who did calculate an incorrect volume, most of their answers were sensible values; what is extraordinary is that some candidates are content with an answer such as 0.02 cm^3 as a volume that could contain 1.6 million tonnes of salt.

2) (a) Explaining the rate of reaction caused candidates some difficulty and a number resorted to descriptions involving the tome at which a reaction takes place.

(b) (i) In general this was very well answered and there is no doubt that this topic is one that most candidates are able to master.
(ii) Again this very well answered. Very few candidates lost marks here and even those few who had failed to gain full marks in part (i) still gave a correct expression based on their previous answer.
(iii) This was undoubtedly a little more challenging than the preceding two parts but many candidates were able to calculate a correct value although fewer were able to work out the appropriate units.

(c) (i) Only the very weakest candidate failed to describe correctly the rate-determining step as the slow stage in a multi-stage reaction.
(ii) This was a very challenging question and there were only a handful of candidates who achieved full marks here. It was a little depressing to see how many candidates suggested steps that were chemical nonsense and involved steps that were neither balanced nor added to give the overall reaction.

(d) Many candidates were able to construct a fully balanced equation for the formation of nitric acid although some candidates did not seem to realise that the species were all given in the opening sentence of the question. When it came to using oxidation numbers to show that it was a redox reaction, the answers were rather poor, certainly more so than in previous years. A large number of candidates were satisfied with showing only that nitrogen was oxidised from +4 to +5 and did not discuss the changes to oxygen. Of those, who did, the most common error was to assign an oxidation number of –6 to the oxygen in HNO_3.

3) (a) (i) This was well answered with most candidates making the link between the strength of an acid and the size of the acid dissociation constant.

(b) (i) Again the majority of candidates picked up both marks here.
(ii) The vast majority of candidates realised that one acid would protonate the other although many chose phenol as the acid rather than ethanoic acid.

(c) The quality of answers to this part was extremely pleasing. Even weaker candidates who scored poorly in the rest of the paper had clearly learned how to do these calculations and so many gained full marks here.

(d) On a positive note, most candidates realised that the answer was linked to the different strengths of the two acids and so their different degrees of ionisation. As a result this mark was awarded the most frequently. Fewer were the candidates who were able to explain why the volume of hydrogen would be the same in each case. When it came to the equations a large number of candidates were able to give a correct equation for the reaction of magnesium with hydrochloric acid, but very few were able to do the same for the reaction with ethanoic acid. The most common error was to write CH_3COOMg. This is an extremely serious error as within two lines candidates are happy to change the valence of magnesium. More serious were the number of candidates who gave the formula of magnesium chloride as MgCl. Again it is depressing to think that candidates who can handle a reasonably sophisticated calculation such as that in part (c) are then unable to write the correct formula for magnesium chloride.

4) This question was certainly the most challenging on the paper. Many candidates were able to describe correctly the action of a buffer solution as one that minimises changes in pH on addition of small amounts of acid and alkali; some then went on to contradict themselves later in their answer by referring to the maintenance of a constant pH. The quality of the rest of the answer really divided the candidates into two groups. The first group clearly had a reasonably sound idea of the species involved and were able to show how these coped with the addition of H^+ or OH^-. Although few gave a correct equilibrium equation the chemistry they discussed was at least sound. The least awarded mark was one allocated for identifying that ammonium chloride was the source of the ammonium ion. The second group of candidates failed to identify the species involved with many proposing that NH_3 would dissociate into H^+ and NH_2^-. Subsequent explanations then often discussed the role of ammonia as an acid! The idea of buffer solution is one that candidates find very difficult and although there were many poor quality answers to this question, it was at least pleasing to see that some candidates were able to gain full marks.

5) (a) (i) The majority of candidates were able to calculate correctly the amount of sucrose but many simply stopped at this point and, even though Avogadro's constant was given in the question, they did not then multiply this by the number of moles of sucrose.
(ii) A number of candidates appear to have missed the first bullet point and did not attempt to give a balanced equation for the combustion of sucrose. Of those who did attempt this part, the most common error was to fail to get the correct stoichiometric coefficient for O_2. In answering the calculation most candidates converted correctly to calories but fewer remember to use the amount of sucrose in their calculation.

(b) Most candidates were able to deduce the formula using the percentage data but few worked out the relative molecular mass from the density. In fact, the majority of candidates ignored this piece of information from the question entirely.

(c) It was impressive to see how many candidates tackled this extended calculation in a series of logical steps. Of the errors that were made, only a few candidates failed to scale by a factor of ten. The most common mistake was to ignore the stoichiometry of the equation and so not to realise that the amount of **A** would be half the amount of the sodium hydroxide. As in question 2(d), candidates did not use the information in the question. In this case candidates are told that **A** contains two acidic hydrogen atoms per molecule. Even when the answer did not match the relative formula mass of any of the acids, these candidates were still unable to realise their mistake.

2816/02: Unifying Concepts in Chemistry (Coursework)

General Comments

Centres generally coped well with the administrative burden of coursework and it was pleasing that the moderators found this year that fewer adjustments than usual were necessary to ensure compatibility between candidates. This was particularly apparent with Centres tackling the option for the first time and it is greatly to the credit of those departments who took the trouble to attend meetings and understand the requirements of an unfamiliar scheme. There was some feeling that some more experienced Centres had begun to apply the criteria too liberally and without refreshing their memory of their precise nature: in these cases a word of caution may be necessary.

A very small number of Centres were still found to be using the original set of exemplar experiments and it may be necessary to repeat that use of the second edition of the Coursework Guidance is now obligatory.

Inevitably a number of issues arose and these are reviewed below.

The identification of an organic functional group is widely used for skill P and many Candidates succeeded in producing a reliable flowchart. However, they were often less successful in giving details of the tests to be used. Full, accurate details must be provided if P7b is to be awarded. The oxidation of vanadium practical is a good test of practical skill but it should be noted that Candidates are expected to include observations other than those provided in the instructions before I7b is allowed. The results for the titrations must be in a 3 : 1 ratio and the moderators were somewhat bemused by Centre results which suggested otherwise.

The evaluation of the iron(II) sulphate and copper sulphate experiments causes some difficulty. It should be appreciated that for the higher levels, Candidates must firstly consider potential issues involved with the heating (decomposition of the anhydrous solid obtained, absorption of water as the solid cools and so on) and, secondly, consider whether this did appear to have an impact on the results they obtained. For example, if the anhydrous solid did decompose the number of molecules of water of crystallisation calculated would be too large.

If the rate experiment is used to test skill P, then Centres should note that it is necessary to demonstrate the process as Candidates must use this result as a basis for establishing the compositions of the mixture they are going to use. Failure to do this means that P7b cannot be awarded.

Comments on Individual Skills

Skill P There is a need to emphasise that, for level 7 to be awarded, candidates should have provided instructions sufficient to allow the experiment to be performed exactly as described. Too often, Centres appeared to credit work which provided the background theory followed by an outline procedure but no detail. Centres are also reminded that P7a requires references to be accurate to at least the relevant chapter or, in the case of internet sites, to beyond the first slash (‘/’). Occasionally Centres penalised candidates at P7a for the failure to evaluate the information obtained form their references but, if the experimental procedure subsequently described is reliable and accurate, it can normally be assumed that the evaluation has been done

Skill I This was usually satisfactorily assessed but Centres sometimes gave marks too easily within the ‘b’ strands. At the higher levels, observations should be complete and accurate and readings should be tabulated in a clear format and to an appropriate level of precision. Correct units are essential.

Although a generous view was taken at moderation of the candidates’ notes on potential hazards it is necessary to reiterate the point that was made last year. The precautions should be within the context of the experiment and relevant to the concentrations of reagents being used. Copying details from a ‘Hazcard’ is rarely suitable and leads to candidates to believe that acid which is an irritant at the concentration being used is corrosive. It should also be noted that it is sometimes the products of a reaction that are the cause for concern rather than the starting materials.

Skill A This skill is usually the most reliably assessed but there was some concern expressed by moderators that calculations were not always being checked sufficiently carefully to spot arithmetical mistakes. Some candidates created a smaller, but nonetheless significant, error by rounding numbers during the course of a calculation. Although the final answer should always be expressed to an appropriate number of significant figures, the full number of decimal places should be kept in the calculator until this point has been reached.

Skill E Marks tended to be lower for this skill which reflects its greater difficulty for candidates. There is no doubt that candidates need to be given extensive practice at evaluating experiments before an assessment is carried out. It is not a requirement that measurement errors should be expressed quantitatively but it may be wise to teach this as a matter of course. It is evident that Centres who use this approach aid their candidates in locating those measurements that have significant uncertainty.

The procedural errors identified must be inherent within the experimental method being followed and not related to carelessness in performing the task. For example, to state that a balance should be cleaned of any solid spilled on it previously should be part of normal laboratory practice and cannot be allowed as an improvement.

2816/03 – Unifying Concepts in Chemistry (Practical Examination)

General Comments

There was a slightly increased entry for the Practical examination this year. The quality of scripts seen covered a wide range of ability, but the standard of answers to the Evaluation was particularly disappointing. On the other hand the standard of accuracy shown in the unfamiliar titration was very pleasing indeed.

We apologise for failing to include a Bunsen burner and test tube holders in the list of apparatus in the INST (Confidential Instructions).

There was no evidence that many candidates were significantly short of time on the paper.

Comments on Individual Questions

PLAN (A) The standard of most plans was very good, though there were rather fewer scoring full marks compared to earlier years.
The weakness in many plans was lack of detail about how the solution of iron(II) sulphate for the titration should be prepared from the sample of cast iron. For example, many candidates were not aware of the importance of using excess sulphuric acid to ensure that all the cast iron had reacted. It was disappointing that most candidates made no mention at all of filtering the mixture to remove the insoluble non-metallic impurities in the cast iron, prior to making up the standard solution.
The titration was generally described very well. Some weaker candidates omitted to mention the need for acidification during potassium manganate(VII) titrations. This year, Examiners were a little stricter in awarding the mark for stating the need to obtain consistent the titres: candidates were expected to make it clear that only accurate titrations would be included in calculation of the mean.
Candidates should be discouraged from presenting specimen calculations in an algebraic form or simply in words. In these cases, it is often not possible for Examiners to be absolutely sure that the candidate understands the calculation. Making use of virtual figures is a better approach. However, use of 25.0 cm^3 as a titre in a specimen calculation should be avoided, because of possible ambiguity with the 25.0 cm^3 of solution measured by pipette.
When discussing safety, candidates should select only information that is relevant to the procedure being described. Too many candidates rely on a ‘grapeshot’ approach, by quoting paragraphs of information, much of which is relatively trivial. Candidates are penalised for over-stating the hazard of chemicals used: for example, dilute sulphuric acid is only corrosive at concentrations above 1.5 mol dm^{-3}. When quoting book sources, candidates should give page numbers on which they found relevant information. The quality of written communication was generally very high. Some candidates were penalised for failing to include a word count and it is worth emphasising that candidates who quote incorrect chemical formulae or incorrect units in their plans also risk a penalty.

TEST (B) **Part 1** Since few candidates had carried out this particular titration before, the standard of accuracy was very good. It is hoped that many Centres will use this as part of their teaching programmes to give their candidates wider experience of executing redox titrations. Some candidates lost marks by failing to record burette data in the manner instructed on the question paper. There are a small number of Centres whose candidates only record the titre, but not the initial and final burette readings. This loses 2 presentation marks.

Part 2 Able candidates had no difficulty with the calculations. It is disappointing that a significant minority of candidates think that 0.017 is an answer to **three** significant figures. Most candidates were able to work out ionic half-equations and then combine them successfully in (e). In (f), a number of candidates forgot to "scale up" quantities to 250 cm^3.

Part 3 Most candidates had no difficulty with the analytical tests. Some problems were caused for those who failed to read all the information provided. For example, in (b), some suggested methylpropan-2-ol as the tertiary alcohol. Just a few candidates were obviously caught out by having some organic chemistry on the Practical Test.

Part 4 Although it is recognised that the Evaluation section was demanding, the standard of answers was very disappointing, even from many otherwise very good candidates.

Very few candidates gave the correct answer, 144 cm^3, to (a), but 2 marks out of 3 were awarded for answers of 96 or 192 cm^3.

Answers to (b) were very poor. Many candidates suggested ideas such as gas leaking out, friction in the syringe, the need for stronger heat (despite the information given on the facing page) or the need for larger quantities of both chemicals. Presumably they had not considered that the volume of gas obtained was **much** lower than that expected from the calculation in (a). Some candidates did realise that the solubility of ammonia in water would, on cooling, be a problem. Few appreciated that at least 0.008 mol of NaOH would be needed to ensure that all the NH_4^+ ions in the double salt would react. Only very able candidates identified the green precipitate and realised that some of the NaOH added had reacted with the Fe^{2+} ions instead.

Question (c) was also poorly answered. Few candidates contrasted the highly divergent results of the student as unreliable with the consistency of their own titration results indicating reliability. Most candidates attempted instead to compare the accuracy of the two procedures.

Many candidates were grateful for a straightforward final question in (d)!

Advanced GCE Chemistry 3882/7882
June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	46	40	34	28	22	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	48	42	36	30	24	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	93	83	73	64	55	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	93	83	73	64	55	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	86	76	66	56	47	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	68	59	50	41	33	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	67	59	51	44	37	0
	UMS	90	72	63	54	45	36	0
2815B	Raw	90	66	59	52	45	38	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	70	63	56	49	43	0
	UMS	90	72	63	54	45	36	0
2815D	Raw	90	68	61	54	47	40	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	67	59	51	44	37	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	94	84	74	65	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	94	84	74	65	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	88	77	67	57	47	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	20.3	40.1	58.1	73.9	86.4	100.0	14192
7882	28.6	54.3	73.6	87.3	96.2	100.0	10291

For a description of how UMS marks are calculated see:
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

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1 I enclose a **cheque** ☐ (✓) All cheques should be made payable to 'OCR'
2* **Please invoice** ☐ (✓)
3 Please debit my **Credit Card** ☐ (✓) **Expiry Date** ☐☐☐☐
Mastercard ☐ Switch ☐ Visa ☐ Eurocard ☐ Delta ☐
Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Security code ☐☐☐
Signature .... **Date** ....

* Option for OCR centres only

For official use only: Free / 84 / 94 / 110 / 120 / 150 / 160 / 180 / 190 LBF: £ M06

Terms and conditions

By submitting your booking, you are agreeing to:

1. The booking process

- Bookings are taken on a first come first served basis and must be **in writing.** (Provisional and telephone bookings cannot be accepted.)
- Complete **all** relevant sections of the form. Purchase orders alone cannot be accepted without attached booking forms
- We will **confirm your place by letter**. If you have not heard from us 14 days before the course, contact us to check we have received your booking
- If your chosen date is full, we will place you on a waiting list and contact you should a place arise or an extra date be organised
- We try to meet special and dietary needs stated however we cannot guarantee to meet all requests.

2. Payment process and early booking discount

- The **special offer of £10 early booking discount** applies to post-September full priced courses only and excludes any courses of £50 or less
- Bookings for charged courses will be accepted only if accompanied by the full fee, an official body has agreed to be invoiced or payment has been made by credit card (to include the 3 digit security code).

3. Cancellations and late bookings

- You must give **14 days' written notice** to qualify for a full refund. If you cancel within this time or fail to attend for any reason, you must pay the advertised fee
- **Non attendance** at **free courses** without providing 14 days' written notice will incur a **£50 non attendance charge**
- You can notify us of substitutions to original nominees on free or paid courses at any time without charge
- We cannot normally accept bookings within seven days of the course date
- If a late booking ie within seven days of the course date can be accepted, a **late booking surcharge** of £35 will automatically be levied. No refund will be possible if a late booking is cancelled.

4. Cancellation of courses by OCR

- OCR reserves the right to amend or cancel a course at any time without liability for any travel or other cost incurred by the delegate. We strongly recommend you take out travel insurance if you pre-book travel tickets in case of cancellation
- OCR will not refund the course fee or other costs should you book a course place in error and fail to provide adequate cancellation notice
- OCR will make such adjustments as are reasonable to the Disability Discrimination Act.

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OCR Information Bureau

(General Qualifications)
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