GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Report on the Units

January 2008

3882/7882/MS/R/08J

Oxford Cambridge and RSA Examinations

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

Reports should be read in conjunction with the published question papers and mark schemes for the Examination.

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REPORT ON THE UNITS

Chief Examiner's Report

General Comments

The two main entries this session continue to be *Foundation Chemistry* (16,402) and, *Chains, Rings and Spectroscopy* (nearly 9,199 entries). In addition, nearly 5,743 candidates took the AS *Chains and Rings* examination, the majority being re-sit candidates also sitting 2814. The majority of candidates taking 2811 were doing so for the first time.

For *How Far? How Fast?*, over 1,187 candidates made use of the January session of the A2 year re-sit. Of these, 59% carried forward coursework, 18% took the coursework component and 23% the practical exam.

Over 1,300 candidates were entered for *Trends and Patterns*. As in previous sessions, the most popular optional unit continues to be *Transition Elements* (51%), followed by *Biochemistry* (34%) and then *Methods of Analysis and Detection* (15%).

The entry of 2816/01 was small (only 300 candidates) and, except for one large centre, was again dominated by re-sit candidates. The majority of centres had an entry of just a single candidate.

The entry for *Foundation Chemistry* continues to increase with 1,200 more candidates sitting the January 2008 exam than in January 2007. The entry for *Chains, Rings and Spectroscopy* also experienced the less dramatic increase on 440 candidates. Re-sit entries seem to have stabilised with similar entries in January 2008 as in January 2007.

A feature of candidates' responses is the great reliance placed by many on the published mark schemes. Some candidates seem able to memorise swathes of these documents and to reel these off almost verbatim when required. Ironically such candidates can sometimes be thrown completely by questions requiring application of chemistry especially when tested within a novel context.

Entry to modules

Centres are again reminded of the codes that are to be used for entry in those units of assessment with more than one component.

AS

2813	A	*How far? How fast?* + Coursework
2813	B	*How far? How fast?* + Carry forward coursework mark
2813	C	*How far? How fast?* + Practical exam

A2

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

Options

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

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2811 Foundation Chemistry

General Comments

The overall impression of this paper was that it showed candidates performing at a slightly higher standard than in previous years. In particular candidates seemed much better able to describe trends in ionisation energies, the test for the halide ions and the hydrogen bonding in water, than has been the case in earlier papers. Elsewhere there was also the feeling that candidates came very close to being awarded marks but failed to explain their answers in sufficient detail and perhaps, as a result of rushing, did not do themselves full credit. This was certainly true of the answers to 1(d) and 2(a)(ii) and again in 3(b)(ii). Candidates should be encouraged to read the question very carefully and to take a little time thinking about how best to explain the answer. Of all the areas examined here the greatest weakness still remains candidates' understanding of how intermolecular forces are involved in changes of state. All too many candidates seem content to venture answers which suggest that covalent bonds are broken when compounds are vaporised. This reveals a true lack of understanding and is an area on which candidates should concentrate for the future.

Comments on Individual Questions

Question 1

(a) (i) Almost all candidates got off to a good start with this opening question. As in other parts of the paper, candidates should be careful not to rush but rather to make sure that they take the time to convey fully the answer. For example some candidates lost the mark here by writing 'elements with different number of neutrons', rather than ‘atoms of the same elements with ……’.

(ii) Very few candidates failed to pick up these easy marks.

(b) (i) As in previous years this stock definition still failed to furnish many candidates with all three possible marks. Most common of the possible errors was to fail to convey the idea of an average or weighted mean mass. In addition, there were a number of candidates who used 'moles of atoms' or 'grams' in an incorrect manner.

(ii) This was well answered with the majority of candidates identifying that the boron-11 isotope must occur in greater abundance. Pleasingly a handful also worked out that this figure is 80%, although this did go beyond the required answer.

(c) (i) Candidates really struggled with this equation despite the fact that both reactants and one of the two products are given in the question. Many, as is often the case, were let down by a lack of simple chemical knowledge and so led to venture incorrect formulae for potassium hydroxide and thus making the equation impossible to balance correctly. Many invented $K(OH)_3$ in an attempt to attain a balanced equation.

(ii) This part of the question was on the whole much better answered. Almost all candidates identified the oxidation number in elemental boron as zero and the vast majority were able to assign +3 to the boron in boric acid.

(d) Candidates found this part of the opening question quite challenging and it was uncommon to be awarding full marks here. Often there was the feeling that candidates probably did know the answer but failed to explain themselves in sufficient detail to pick up all the marks. Of the two bond angles, that at the boron was more often given correctly than that at oxygen. Many candidates worked into their answers at some point the idea that pairs of electrons repel one another but very few gave the number and type of electron pairs surrounding both central atoms. Many claimed that atoms repelled. The commonest misconception is that lone pairs alone repel and lone pairs alone influence the molecular shape. Some candidates thought it sufficient to link the given molecule to BF_3 and H_2O by way of explaining their choice of angle.

Question 2

(a) (i) Candidates found it difficult to recall the industrial route to quicklime. Although there were many who knew the answer and even gave equations to back it up, others resorted to ideas about burning calcium in air or suggested that quicklime was a product of the blast furnace.

(ii) This part received better answers. Unfortunately, many failed to score the mark by being too vague, for example saying that it could be used to 'neutralise fields'. The examiners did require the word 'acid' so that the direction of neutralisation was indicated.

(b) (i) In the main this was very well answered. Some candidates were clearly put off by leaving sections blank and either wrote in '1' or else resorted to doubling the stoichiometry.

(ii) Again there were good answers here. Common errors were to forget to change units from cm^3 to dm^3. In addition, a few candidates threw away the mark by giving an answer that had not been rounded correctly.

(iii) This was almost always correctly answered even by candidates having to carry forward their error from part (ii). Some candidates did multiply by 2 rather than dividing.

(iv) Again this was very well answered. A few candidates became a little muddled and used the value of 22.45 cm^3 rather than 25.0 cm^3

(v) This was possibly the hardest question on the paper and it was clear from the scripts that many candidates simply had no idea how to approach the answer. A number did make it through to calculating 164.1 as the relative formula mass of $Ca(NO_3)_2$ but from this point could still not see their way to the correct answer. Significantly most candidates scoring in the 50s on the paper had little difficulty with this part so it discriminated extremely well at the top end.

(c) As in 1(c)(i) candidates again found it difficult to produce a fully balanced correct equation. Many ran into difficulty by reading incorrectly into the question that limewater would be the only product and so not realising that hydrogen would also be produced. Of those who realised that hydrogen featured as a product, nearly all picked up both marks.

(d) (i) Generally this was well answered although more candidates omitted the state symbols than have made this mistake in previous years.

(ii) Candidates found this calculation challenging. Remarkably there were many who failed to work out the number of moles of Ca atoms correctly, and some who simply took the value as 5. In addition, candidates then used only the second ionisation energy rather than the sum of the first two ionisation energies. Nearly all candidates who did manage to avoid errors in these initial stages went on to quote the answer to the required three significant figures. There were, however, few candidates in this final category.

(iii) This was well answered and showed a significant improvement in the quality of responses to this question from previous years. Particularly pleasing was the number of candidates who talked about the increased nuclear charge being outweighed by the increase in both distance and shielding. When candidates did go wrong, it was not uncommon for them to muddle group with period and to describe how ionisation energy varies across the periodic table.

Question 3

(a) This was a very easy opening part and virtually the only candidates not to get the mark were those who made a simple slip.

(b) (i) Many candidates found these easy marks to pick up but there were a significant number of candidates who lost a mark by not denoting the occurrence of two chloride ions correctly. In such cases it would have been better for the candidate to take the time to draw out the chloride ion twice.

(ii) In the main there were good answers to this question. Some candidates again rushed at the answer and failed to note that a discussion of the conductivity in magnesium was also needed in the answer. As in previous years the most common error was to talk about electrons being able to move when $MgCl_2$ is dissolved in water

(c) Again this was well answered with most candidates picking up two of the available three marks. Most candidates identified that the nuclear charge was increasing while the electrons were being added to the same shell but fewer went on to explain how this leads to an increased attraction between the electrons and the nucleus.

(d) This was a challenging part as candidates needed both to convert a volume of gas into moles and subsequently use the stoichiometry of the equation to decide on which reagent was in excess. In the end a significant number of candidates did not make it to the second part of the question as they were unable to convert 145 cm^3 of Cl_2 gas into moles of Cl_2. It is slightly surprising that candidates found this quite so challenging. Even for those candidates who did work out this first part correctly, many were then unable to employ the 1:2 ratio of the reactants to arrive at the final answer. The commonest error was to ignore the stoichiometry and then to claim incorrectly that NaOH was in excess.

(e) Of the two possible sets of answers to this question, the addition of silver nitrate was only slightly more popular than displacement reactions involving chlorine . In general the answers were impressive and many who described correctly the precipitates formed by the silver halides also went on to describe how they would behave in dilute or concentrate ammonia solution. A few marks were dropped as a result of confusion between chlorine, chloride and Cl, but again this error was not as frequent as in previous years. Some brave candidates chose to carry out their displacement reactions with fluorine.

Question 4

(a) Many candidates were clearly delighted to see the opening part of this question and quickly picked up all 7 marks. In showing the arrangement of a hydrogen bond between two water molecules the most common omission was to fail to involve the lone pair. In discussing the anomalous properties some candidates simply stated that the melting point and boiling points would be high without conveying the idea that it is unusually high. Others gave the property of a high surface tension and consequently found this very difficult to explain.

(b) Once again, as in previous years, this question revealed the confusion that many candidates have about the difference between bonds within molecules and intermolecular forces. Candidates' opening remarks about methane were more likely to be correct than those concerning hydrogen chloride. Consequently the most commonly awarded mark was for identifying the van der Waals' forces present between molecules of CH_4. On moving on to discuss HCl, candidates often showed their misunderstanding of this difficult area of chemistry. Possibly as a consequence of part (a) some candidates focussed on the idea of hydrogen bonding and erroneously discussed this in relation to molecules of HCl. Others talked about breaking the covalent bond upon boiling hydrogen chloride while others gave the bonding as ionic. Significantly, as in 2(b)(v), the ablest candidates collected these marks with comparative ease and this part served to be a very good discriminator at the top end

2812 Chains and Rings

General Comments

The paper produced a spread of marks with the marks ranging from below 10 to THE high 50s. The majority of the candidates were Year 13 students and were re-sitting this module after completing the A2 unit: *Chains, Rings and Spectroscopy*.

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

Each of the five questions was accessible to all students, but each question contained parts that stretched even the most able candidates. The extended writing question, Q5, proved to be more difficult than anticipated with very many students unable to write in prose and very many confusing the chemistry with other sections of the overall specification.

Comments on Individual Questions

Question 1

This was a gentle starter in which most candidates scored well. Most candidates now seem to appreciate the difference between intermolecular and intramolecular forces and are aware of which are relevant for physical changes such as boiling.

(a) (i) & (ii) These parts were well answered with most scoring both marks in each. A substantial number of candidates correctly described the way in which the intermolecular forces varies with chain length and with branching. However, many forgot to relate this to boiling point.

(iii) Good candidates found this easy, but weaker candidates seemed to guess at a number without any reference to the data provided.

(b) (i) This was well answered although some ignored the instructions to use skeletal formulae.

(ii) The word reforming (or reformed) seems to confuse many who simply reversed the previous section in (b)(i) and reformed dimethylpropane back into pentane.

(iii) Most scored the mark.

Question 2

(a) This was surprisingly difficult. The mark scheme was eased to try to include bond enthalpy and the lack of polarity to explain the reactivity of the alkanes.

(b) (i) This was reasonably well answered but a surprising number failed to score this mark.

(ii) & (iii) This was very easy with most scoring the marks.

(iv) Good candidates applied what they had been taught and picked up both marks. Weaker candidates simply recalled what they had been taught and wrote equations for the propagation steps in the chlorination of methane. It was also common to see the formation of chloropropane in the first propagation step which inevitably meant that both marks would be lost. Others misinterpreted the question and wrote an equation for the homolytic fission of chlorine as the first propagation step.

(v) This was well answered but many lost the mark by poor use of chemical terms, *e.g.* referring to propane molecules instead of propyl radicals.

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

(ii) This was very poorly answered with even able students describing carbon dioxide as toxic or poisonous. Coverage in the media seems to have instilled in candidates' minds that carbon dioxide is a nasty dangerous gas.

Question 3

(a) This was an easy five marks for candidates who had learnt the work.

(b) Mechanisms now seem to be well understood and very many scored all four marks.

(c) (i) This was tricky and only the best students were able to translate the monomer, prop-2-en-1-ol, into a section of the polymer.

(ii) & (iii) Both parts proved to be surprisingly difficult with very many unaware of the convention for writing equations for addition polymerisation and for naming polymers.

(d) (i) This was much better answered than in previous papers although part (ii) proved to be demanding for all but the most able. Many candidates redrew hydroxypropanone which was given in the question, other drew tri- and penta-valent carbons and many drew the same isomer twice.

Question 4

An unusual format required candidates to solve a problem and to identify a particular isomer. Very many did this well and scored high marks.

(a) This was straightforward for most.

(b) (i) This easy mark was scored by almost all candidates.

(ii) & (iii) Many used the mass of a bromine atom rather than a bromine molecule for the calculation and the majority failed to see the connection between parts (ii) and (iii). Only a very few used the mole ratio of compound **A** and bromine to deduce that there must have been two double bonds in compound **A**.

(c) This was very easy with almost all scoring the mark.

(d) Most correctly identified linalool and recognised it as the only tertiary alcohol.

(e) This was again well answered and very many correctly drew a correct organic product.

Question 5

All candidates attempted this question and there was no evidence that they were rushed or ran out of time. However, very many were challenged by the question and few, if any, followed the guidance given by the three bullet points. Poor prose and poor examination technique abounded.

Many failed to include any equations at all. Others confused this with the displacement reactions between the halogens and the halides and many failed to use silver nitrate at all. The mark scheme was flexible such that candidates should have been able to score full marks.

2813/01 How Far? How Fast?

General Comments

It was evident that candidates had generally prepared well for this paper so that some very well expressed answers were seen to all questions. The more able candidates approached problem-solving questions, such as calculations, logically and explained exactly what they were doing.

There were a number of responses when balanced equations, molecular or ionic, were needed. Weaker candidates found these difficult and often omitted balancing numbers or state symbols – even when these were specifically asked for. It was particular disappointing to note the number of occasions in which the formula of sodium chloride was given as Na_2Cl_2 in Q3, even though the correct formula was given in a table in the question.

A suitable method of approach to answering Q4 was suggested by separating out exactly what was needed to obtain high marks. Most candidates responded well to this and did address the issues as quoted.

Comments on Individual Questions

Question 1

(a) Most equations for the enthalpy change of combustion were correct.

(b) Most candidates recognised that the expression, energy = $mc\Delta T$, was needed. Only very few used the mass of methane, rather than that of water. Some marks were lost when an answer in J was quoted as if it were in kJ.

Ans: 26.3 kJ

(c) The number of moles was almost always calculated correctly.

Ans: 0.0375

(d) Although most candidates correctly divided the relevant numbers, only the most able recognised that the change is exothermic and therefore has to be negative.

Ans: –701 kJ

Question 2

(a) (i) Most candidates realised that Hess's Law was concerned with combining enthalpy changes of reactions. Some gave rather confused statements.

(ii) This is an example where some weaker candidates showed their inability to write equations. There were a significant number that used 2N or H_4, gave the state symbol for hydrazine as being (g) or (aq) or omitted the state symbols altogether.

(iii) More able candidates drew logical cycles and hence obtained a correct answer. Weaker candidates sometimes appeared to use the data given almost randomly. The correct numerical answer, with a positive sign, was a commonly obtained result.

Ans: –533kJ

(iv) To be awarded this mark it was necessary to be precise. It was therefore not acceptable merely to state that 'harmless products would be produced'.

(b) (i) Most candidates gave two acceptable features. Some were clearly confused with the implications of le Chatelier's principle and quoted the effects of changing conditions on the equilibrium.

(ii) Nearly all candidates recognised the need to compare the bond enthalpies being broken and made. Some errors arose in how many of each bond was involved but the most common error was assigning each operation the wrong sign.

Ans: –154 kJ

(iii) It was pleasing to note that most candidates correctly used their answer to (ii) and the number of moles in the equation to predict suitable conditions.

Question 3

(a) The definition was nearly always acceptable with very few answers based on pH or containing hydrogen being seen.

(b) (i) Even though they were given in the question, there were large numbers of equations containing incorrect formulae. This, the omission of state symbols or failure to balance, meant that many marks were lost.

(ii) To gain credit it was necessary to give a precise answer. It was therefore insufficient to comment that the particles need to move faster.

(iii) Most candidates did respond to the instructions in the question and quote observations. However, in spite of once again much relevant information being given in the data table, many responses gave incorrect colours *etc*.

(c) (i) Most answers were correct.

(ii) Many correct equations were seen but some candidates appeared to take too literally their response to (i) that complete dissociation was needed. This meant that they dissociated chlorate(VII) into more than two ions.

(iii) Many correct equations were again seen but a significant number tried to involve Cl^- in some way.

(iv) In spite of the fact that it was stated that both acids were strong, many candidates suggested that the rate of one, usually hydrochloric, would be faster. Only the most able candidates recognised that it is the **concentration** of H^+ ions that is significant.

Question 4

As noted previously, many candidates followed closely the guidelines given in the question and gained high marks. Weaker candidates seemed confused about the difference between an enthalpy profile diagram and a Boltzmann distribution. A wide variety of heterogeneous catalysts were suggested. It was clear that some candidates were drawing on the knowledge they had gained in studying other units – usually *Chains and Rings*.

2813/2816/02 AS/A2 Coursework

General Comments

The entry for the January examination session consisted largely of candidates repeating the coursework component in an attempt to improve their mark. While some clearly had made considerable strides in the quality of the work they produced, it was evident this was only achieved where the candidate had taken the trouble to re-consider what was required. There remained a number of samples of work that seemed to have been submitted with the faint hope that by trying other experiments improvement would somehow be inevitable. Particularly in the case of the evaluation of experiments, there is a level of understanding which can only be acquired by appropriate study and the acquisition of experience.

The Moderators were grateful for the extensive annotations that were present on most of the scripts and appreciated the instances where teachers had taken the trouble to explain in more detail why a particular mark had been awarded. It is worth emphasising that any extra detail that is provided by the centre is considered carefully by the Moderators. An often repeated complaint however was that the coursework had been despatched late from centres, which could potentially lead to a hold-up in the processing of marks.

Unfortunately it is hard not to repeat many of the concerns that have been expressed in the past. These mostly concern the award of the higher levels for the various skills. Centres should, in particular, note that for P7a to be covered, Candidates are required to provide two references that are at least to the chapter of a book or beyond the first ‘/’ of an internet reference. There were a disappointing number of cases where this had not been done. Correct use of sub- and super-scripts is also considered part of the ‘punctuation, spelling and grammar’ requirement and, although the odd slip can be forgiven, several failings must be penalised.

Comments on AS Coursework

A popular choice for the planning exercise was the decomposition of copper carbonate. Candidates scored well up to level 5 but many failed to achieve P7b because they used a colour change to black as a means of identifying when decomposition is complete. This assumes the answer and would be unreliable.

Where the choice of plan was the hydrolysis of halogenoalkanes many failed to make it clear what nucleophile was involved.

Implementing was reliably marked on the whole but candidates cannot be awarded I7b if they fail to record the initial burette reading when a titration is performed. It should also be appreciated that a 250 cm^3 measuring cannot be read to anything more accurate than a whole number of cm^3.

Analysis was generally reliably assessed. There is still however a wide-spread confusion over the use of significant figures. It is an area that requires teaching and it is apparent that many candidates are just guessing what might be appropriate.

Evaluation is a difficult skill both to teach and to learn. There has been some improvement in Candidates ability to recognise what failings there may be in a procedure used but they often find it impossible to identify what errors are significant.

The improvements that are suggested are often ineffective (such as using a syringe rather than collecting over water to avoid the escape of gas in the lithium exemplar) or incorrect (as is the use of an alcohol to clean paraffin off lithium).

Comments on A2 Coursework

Many of the general points raised in the AS report are relevant to the assessment of A2 coursework.

Two planning exercises tended to dominate the small number of scripts received. In the identification of an organic unknown, centres are reminded that for P7b to be awarded, full and reliable details of the quantities used and the essential conditions must be present. If the rate experiment is used, then, for level 7, an explanation of why the chosen graphs are appropriate is expected.

Both Implementing and Analysing are normally well-marked. Candidates are particularly good at identifying the various organic compounds and providing a clear account of their reasoning. A problem still existed for some candidates doing the rate experiment who confused the use of half-lives from a concentration/time graph (which is not correct if an initial rate procedure is used) with the correct plot of rate against concentration.

As with the AS, candidates find the evaluation of experiments hard. It is emphasised that, although no proformas are allowed for A2, E5b can only be awarded if the significant errors in the procedure and measurements are identified. Improvements should also be directed towards steps that could be taken to improve the results that are obtained. This was particularly an issue with those Candidates who provided an evaluation of the formula of either iron(II) sulphate crystals or copper sulphate crystals. In these cases too many settled for generalisations that were not always relevant to their experiment. In the rate experiment, E7b can only be allowed if discussion is focussed on the reasons that the timing may be unreliable and not just on the accuracy of the stopwatch.

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

General Comments

The standard of many scripts was pleasing and most candidates were able to make a reasonable attempt at most parts of the paper. Few candidates achieved very high marks, but there were also very few who obtained very low marks. The Implementation section, involving the enthalpy determination was completed well.

Comments on Individual Questions

Plan

A
Most candidates, even weaker ones, were able to pick up many of the marks for the basic aspects of the Plan. Certain marking points were often omitted. Some candidates did not attempt to dilute the nitric acid before using it in the titration: it is customary to use solutions that are around 0.1 mol dm^{-3}. Justification of quantities used is a high level skill: many candidates, even if they produce some relevant figures, are not always able to explain clearly what the significance of their figures are. Some weaker candidates, although aware that accurate titres should be consistent, spoil their answer by quoting specimen results where the titres are not within 0.1 cm^3. Examiners consider that use of 25.0 cm^3 as a specimen mean titre makes a calculation too easy and was awarded only 1 mark out of 2 on this paper. Similarly algebraic calculations that do not include, for example, values of relative formula masses, do not score full credit.

The gas collection experiment was generally described well. Diagrams drawn by hand should make use of a ruler and be of approximately the right proportion. Many candidates omitted the precaution of separating the reagents inside the flask to prevent premature start of the reaction and consequent loss of gas. More candidates than usual were aware of the importance of using of excess acid, though relatively few were able to show by calculation what quantity of acid would be needed to ensure this.

Most candidates wrote up their Plans well and scored both of the quality of written communication marks. However, some still fail to include a word count and others are careless in their precise use of units and chemical formulae. The quality of word-processed Plans continues to be high, though it would be even better if all students had learned how to print sub- and super-scripts. A number of candidates claimed to have used a very wide range of internet sources for research of their Plans.

Test

B
Parts 1 + 2
The standard of accuracy achieved for temperature difference measurements by almost all candidates in this procedure was remarkably high: many scored all five available marks. A number of candidates were careless in their use of significant figures. Two decimal places should be quoted for all weighings and one decimal place for temperatures.
Some weaker candidates had difficulty in calculating the two enthalpy changes, but the standard of the calculations was higher than when similar exercises have been set in the past.

Part 3

As usual, the calculation based on Hess' Law discriminated well and generally only the most able candidates were able to complete this correctly.

Part 4

The Evaluation section was generally completed somewhat better than usual, although it was the most difficult section for most candidates.

In (a), most candidates referred to heat losses, though it was disappointing that virtually all should not have done so.

The second mark of (b) proved very discriminating: few candidates realised that the temperature rise would be half as great.

The calculation in (c) proved straightforward to most candidates, although not all explained their working clearly enough.

Part (d) proved difficult, though many candidates were able to make one correct relevant suggestion. Few mentioned the inherent difficulty of measuring accurately the amount of heat input needed to cause the decomposition.

2814 Chains, Rings and Spectroscopy

General Comments

The paper produced a good range of marks with many centres clearly preparing their candidates very well. Many candidates were able to demonstrate a thorough knowledge and understanding of the ideas covered in the specification. Teachers had obviously made good use of the published mark schemes of previous papers to help their candidates prepare. The paper contained a mixture of familiar material set in different contexts and some more challenging problem-solving questions designed to give more able candidates a chance to show their ability at the subject. It was noticeable how these questions discriminated between those who had learned the facts and those who can apply their understanding to an unfamiliar problem. Teachers should expect more of this type of question in future papers. Most candidates are now familiar with the additional assessment objectives that were added to the specification from the January 2006 session onwards, although teachers could still stress the use of acid chlorides in synthesis. Most candidates seemed to finish the paper in the time allowed.

Comments on Individual Questions

Question 1

(a) Most candidates sitting this paper appear to be confident with names and structural formulae of organic compounds.

(b) Any value between the boiling points of butanal and hexanal was accepted. The actual value is 103 °C.

(c) Nearly all candidates knew that an orange precipitate forms when 2,4-dinitrophenylhydrazine is added to a carbonyl compound, although in part (ii) credit was only given when they used the data to show that boiling points of different carbonyl compounds may be identical, while the melting point of the derivative is always unique.

(d) All candidates recognised that they needed to calculate the M_r of butanal to give the m/e value of the molecular ion peak.

(e) This question gave an opportunity for candidates with a good understanding of n.m.r. to identify an unknown structure and explain the features on the spectrum. To explain the relative peak areas, candidates needed to specify that the areas are given by the number or ratio of protons of in a particular environment (or words to that effect). Partial credit was available in part (iv) if candidates chose the wrong structure, but only if the peak still corresponded to the same number and type of proton.

Question 2

(a) Most candidates recognised the azo group.

(b) It is pleasing to see that many candidates had a very good knowledge of the reagents and conditions to make an azo dye and could apply this to the structures given. For full marks, the diazonium group did need to be displayed with the + charge on the correct nitrogen atom. The most common error was omission of the alkaline conditions in the second stage.

(c) This part proved more testing, with a fair number of candidates not realising that both the carboxylic acid group and the phenol group would be ionised after reaction with excess sodium hydroxide solution.

(d) Any valid reducing agent was accepted to reduce a nitro group, although most candidates were familiar with the use of tin and concentrated hydrochloric acid. Some however lost a mark by not balancing the equation correctly in part (ii).

Question 3

(a) It was pleasing to see how many candidates could correctly draw the two stereoisomers of glutamic acid using the appropriate 'wedge' and 'dotty' bonds. Some would still benefit from more practice at this skill, but the standard is now much better than in past years.

(b) This part proved to be quite challenging, with the carboxylate group on the side chain also needing to be ionised in alkaline conditions.

(c) Nearly all candidates seemed confident at deducing the structures of the other two amino acids that would result from the hydrolysis of glutathione. While most knew that the tripeptide was formed by condensation, many also described is as polymerisation. This was not penalised, but the term should really only be used for the formation of much longer chains. For the hydrolysis of a peptide, some indication of heating is needed as well as the presence of a suitable aqueous acid or alkali.

Question 4

(a) Most candidates identified the antiseptic properties of phenols as the reason they are used in mouthwashes.

(b) The Friedel–Crafts reaction was much better known than in previous years, with many candidates able to balance the equation and identify a suitable catalyst by name or formula.

(c) This calculation was relatively easy for this level, although some candidates did lose marks by obtaining the incorrect M_r for thymol. The correct value is 150.

(d) More candidates were familiar with the use of acid chlorides in synthesis than previous years, although it is still a less well-known area of the specification. In part (ii) either PCl_5 or $SOCl_2$ was acceptable, although the equation did have to match the reagent chosen. In part (iv), some candidates lost a mark by incorrectly suggesting that one difference between the infra-red spectrum of thymol and the ester would be the presence of the C–O bond only in the latter. It is easy to overlook that the C–O bond is also present in alcohols and phenols.

Question 5

(a) Most candidates knew the structure of propene and the polymer, but the mark was only achieved by those who also balanced the equation correctly with '*n*' to represent the large number of monomers used to make the polymer.

(b) The names of the three stereochemical forms of poly(propene) are generally well known and credit was given for drawing poly(propene) correctly with some indication of the pattern of the side groups along the chain. A common error was to draw the CH_3 groups on adjacent carbon atoms for the atactic or syndiotactic polymers. For full credit, a correct 3-D diagram was needed with the use of suitable 'wedge' or 'dotty' bonds to show that the tacticity is due to stereochemical rather than structural isomerism.

(c) The structure of the monomers and the repeat unit of Terylene was very well known, with most errors being due to connection of bonds to the wrong atoms in the functional groups.

Question 6

(a) The synthesis of an amine by substitution of a halogen with ammonia and reduction of a nitrile seemed to be known only by the better-prepared candidates.

(b) Some credit was given to the many candidates who correctly balanced the equation using ethanoic acid to synthesise the substituted amide. However, full credit was reserved for those who used the acid chloride, which is much more effective.

(c) Many candidates gave a very thorough description of the basicity of amines plus the effects of delocalising the lone pair in phenylamine and the inductive effect in phenylethylamine. For full credit, answers needed to discuss how these affect the availability of the lone pair on the nitrogen atom, which is needed to form the dative covalent bond with the proton. Although this process involves donation of the lone pair, use of the terms nucleophile or electrophile did lead some candidates to confuse this explanation with other areas in this specification.

Question 7

(a) The majority of candidates could describe the overlap of p-orbitals to from the delocalised π-bonding above and below the plane of the ring in benzene. For full credit, a comment on the equivalence of the six C–C bonds or reference to the σ bonding was also needed. The most common error was confusion between p-orbitals and π-orbitals in the descriptions.

(b) This part gave an opportunity for candidates to apply their understanding to an unfamiliar problem. Most who attempted the question scored some credit, although only the more able candidates came up the correct empirical formula and suitable structures for the unknown reagent and hydrocarbon. A common error was to convert the 1:1.25 ratio into an empirical formula of CH or C_5H_6. In this case, marks were still available if a valid structure for the hydrocarbon within the given M_r range was suggested.

Question 8

(a) The reaction with water in the acid hydrolysis of the ester was well known by the more able candidates, but others often included the hydrochloric acid as a reactant rather than a catalyst in the equation. Similarly the products from alkaline hydrolysis were only correctly identified by the better candidates, who identified the salt of butanoic acid and ethanol. In this reaction, water is not a product.

(b) This part gave candidates an opportunity to demonstrate their ability to apply their understanding to an unfamiliar mechanism. Some however lost marks through not being precise enough about where the curly arrows started and ended. It is important that the particular bond or atom is identified unambiguously.

(c) A good number of candidates were able to find one chiral carboxylic acid, but only a few found all three. Any representation of the correct isomer was credited.

(d) This part proved to be very challenging, with only the most able deducing that 3,3-dimethylbutanoic acid would be the only carboxylic acid isomer to have all its protons adjacent to a carbon atom with no protons.

(e) A good number of candidates correctly drew the skeletal formula for cyclohexane-1,4-diol, although a common error was to draw one or more double bonds.

(f) This part also proved to be very challenging. It was easy to overlook the protons connected to the carbon that also had the OH groups attached. This gave a total of three peaks with relative areas 1:1:4.

2815/01 Trends and Patterns

General Comments

The average mark for the paper was 28 which was an increase on the corresponding mean mark for the January 2007 examination paper. The mark range was from 0 to 44. There was very little evidence that candidates ran out of time and only a small proportion of candidates left significant portions of their examination paper blank.

A significant proportion of the candidates did not use chemical terminology with precision but there was some improvement over previous examination papers. In particular, candidates need to refer to the correct particle and/or use the correct formula for any named particle. Typical misconceptions included the use of the *atomic* radius of Mg^{2+}, the carbonate *molecule* and the polarisation of *magnesium carbonate*.

Candidates found the long question on magnesium chloride, silicon(IV) chloride and phosphorus(V) chloride much more accessible than other questions from previous examination papers. Many of the candidates used the bullet points in the question to organise their answers.

Comments on Individual Questions

Question 1

This question focussed on the chemistry of iron compounds.

(a) Only a small proportion of the candidates could not give the electronic configuration for an iron(II) ion and an even smaller proportion could not explain why iron is a transition element.

(b) The most popular correct response in part (i) was $[Fe(H_2O)_6]^{2+}(aq)$. A significant proportion of the candidates gave the formulae of complexes that did not exist such $[FeCl_4]^-$, or complexes of iron(III) such as $[Fe(H_2O)_5(SCN)]^{2+}(aq)$. A very small number of candidates gave copper complexes instead.

The mark scheme for parts (ii) and (iii) allowed full credit for any complex given in part (i) as an error carried forward.

In part (ii) a large proportion of candidates could draw a three dimensional representation of an octahedral shape but a smaller proportion could state the correct bond angle. A common error was to give the bond angle as 109°.

In part (iii) most candidates stated that the bond was called a dative or coordinate bond. Only a slightly smaller proportion of candidates stated that the ligand donated a lone pair.

(c) The most common response described the reaction between $[Fe(H_2O)_6]^{3+}(aq)$ and $SCN^-(aq)$. A significant proportion of the candidates failed to include water in the equation.

The blood red colour of the $[Fe(H_2O)_5(SCN)]^{2+}(aq)$ complex ion was well known by candidates.
Many candidates invented ligand substitution reactions basing their reactions on the chemistry of copper rather than iron(III).

(d) Many candidates gave the correct colour for iron(II) hydroxide and iron(III) hydroxide but failed to mention it was a precipitate and so were not awarded a mark.

Although a significant proportion of candidates could write an ionic equation many candidates either omitted state symbols or gave incorrect state symbols such as $Fe(OH)_3(aq)$. Only an extremely small proportion of the candidates wrote molecular equations.

(e) A large proportion of the candidates were able to deduce the correct oxidation states and consequently explain that Cr^{3+} was oxidised and FeO_4^{2-} was reduced.

(f) Only an extremely small number of candidates could balance the redox equation. However, one mark was available for an unbalanced equation with the correct formulae of the reactants and products.

Question 2

Candidates of all abilities were able to draw recognisable Born–Haber questions but frequently candidates found parts (c) and (d)(ii) very demanding.

(a) Only a small proportion of candidates could fully define lattice enthalpy. A common error was to forget to include the state symbols for sodium ions, oxide ions and sodium oxide in the equation. A common misconception was to define standard enthalpy change of formation instead of lattice enthalpy.

(b) The majority of candidates drew energy level diagrams but other correct energy cycles were given full credit. The most common errors were the use of the wrong formulae *e.g.* $O^+(g)$, wrong stoichiometry *e.g.* $Mg(s) + O_2(g)$ rather than $Mg(s) + \frac{1}{2}O_2(g)$, confusing ionisation energy and electron affinity, only including one ionisation energy and one electron affinity *i.e.* using $Mg^+(g)$ and $O^-(g)$.

(c) The marks were awarded for the explanation. A significant proportion of candidates did not specify the particles involved and so were not given full credit. A common misconception involved the polarisation of the anion rather than focussing on the different sizes of the oxide and carbonate anions.

(d) (i) an extremely large proportion of candidates could write an equation for the decomposition of calcium carbonate. In part (ii) a significant proportion of candidates did not specify the particles involved and so were not given full credit. Candidates needed to compare the ionic radius of the two cations and relate this to the extent of polarisation of the carbonate ion.

Question 3

Many candidates found this question on ethanedioic acid very demanding.

(a) Credit was only given for a colour change that would indicate the end point. Many candidates referred to the appearance of a pink colour.

(b) Candidates needed to calculate the relative formula mass of hydrated ethanedioic acid as 126, and the value of **x** to be 2 to score full marks. Good answers were exemplified by an organised series of steps. Candidates used two different approaches to solve this problem.

Method 1 – moles of MnO_4^-, then moles of $(COOH)_2$, then M_r of $(COOH)_2\bullet \boldsymbol{x}H_2O$ and finally the value of ***x***.

Method 2 – moles of MnO_4^-, then moles of $(COOH)_2$, then mass of $(COOH)_2$, then mass of H_2O in sample, then moles of H_2O, the value of ***x*** and finally the M_r of $(COOH)_2\bullet \boldsymbol{x}H_2O$.

Candidates that used method 2 often forgot to calculate the relative formula mass.

One common misconception was to use the wrong mole ratio when working out moles of $(COOH)_2$,

Only a very small proportion of candidates were able to deduce the correct formula, $(COO)_2Mg$. A variety of incorrect formulae were given including $(COOH)_2Mg$, $MgCO_3$ and COOMg.

Question 4

A large proportion of candidates found this question accessible and many candidates scored above ten marks.

The majority of candidates were able to draw correct '*dot-and-cross*' diagrams with only a small proportion drawing covalent magnesium chloride or covalent silicon(IV) chloride. Most candidates were then able to state the structure of each of the chlorides.

To explain the difference in melting points candidates needed to be able to identify the bonds or force that needed to be overcome and the relative strength of the force or bond. Ionic bonding or electrostatic attraction between ions for magnesium chloride and van der Waals' forces for silicon(IV) chloride were given credit. A further marking point was given for a comparison of the strength of the bonds or force. Good answers referred to strong attraction between ions and weak van der Waals' forces between molecules of silicon(IV) chloride.

Common misconceptions included magnesium chloride having strong intermolecular forces or having a giant structure with molecules. Another misconception was that covalent bonds were weaker than ionic bonds although this was seen somewhat less than in previous examination papers.

Candidates often found the action of cold water on the two specified chlorides more difficult to write about than the melting points. Many candidates could state that magnesium chloride dissolves and gives a solution with a pH of between 6 and 7. Only a few candidates referred to polarisation of water molecules by magnesium ions. A common misconception was that a reaction takes place to make magnesium hydroxide and hydrochloric acid. The pH of the solution obtained after phosphorus(V) chloride reacts with water was well known but candidates were less certain about the equation for the reaction. Even though the phosphorus(V) chloride was in bold in the question a small proportion of candidates described the action of water on the wrong chloride either PCl_3 or $SiCl_4$.

The majority of candidates were awarded the Quality of Written Communication mark which required correct spelling and use of at least three technical terms listed in the mark scheme.

2815/02 Biochemistry

General Comments

The entry was about the same as last year, with many centres having one or two candidates only. The overall standard of work was slightly lower than last year. The best candidates knew the specification thoroughly, and were comfortable applying their knowledge to unfamiliar compounds. Many weaker candidates displayed a lack of familiarity with the specification. Often they found difficulties because of poor understanding and use of chemical terms. In several cases this was made worse by poor writing skills.

Comments on Individual Questions

Question 1

(a) Almost all knew that the structure of an RNA nucleotide was based on ribose, with a base and phosphate attached. The positions of the substituents were not always represented accurately. Common mistakes were to use a skeletal cyclopentane ring or to omit C5 altogether. A few of the best candidates managed a complete structure, which was not expected.

(b) Candidates who correctly discussed translation usually scored 3 to 6 out of 6, as well as the Quality of Written Communication mark. They knew about complementary base pairing and about the importance of hydrogen bonding for that. A minority was able to explain that the base triplets on m-RNA coded for specific amino acids, and the role of t-RNA in bringing each specific amino acid to the correct position in the growing polypeptide. Several thought that amino acids were attached to t-RNA by hydrogen bonds; in fact ester links are involved.

A substantial minority wrote about transcription by mistake. Some managed this sufficiently well that they could rescue most of the marks, but often their answers suggested that this were part of the specification that they had not learnt.

Question 2

(a) Most identified the reaction as condensation, but about half then continued with ‘polymerisation’. This would only have been true for cellulose itself.

(b) This part proved much easier than expected. The great majority answered correctly with 1β-4 glycoside, or stated that the monomer was β-glucose.

(c) (ii) Hydrolysis with acid or with an enzyme was the common response, and many gave more details. A few tried alkali, or plain water, which would not work.

(iii) The majority wrote the correct equation.
$C_{12}H_{22}O_{11} + H_2O \longrightarrow 2C_6H_{12}O_6$
Several clearly worked out the molecular formula of cellobiose using the given structure. A few even gave a balanced equation using full structures. A substantial minority omitted the water.

(d) All recognised that hydrogen bonding was involved, and most drew a good example on their diagram. Too many of the weaker candidates used C–H for hydrogen bonding. Few scored both marks for the importance of internal hydrogen bonds and glycosidic links in limiting the solubility of cellulose.

Question 3

(a) (i) Most candidates drew a correct structure for tributyrin, but several used tristearin by mistake.

(ii) As usual the name 'ester' proved more difficult than the diagram.

(iii) A variety of uses was allowed, and two marks were common.

(iv) Even weaker candidates mentioned van der Waals' forces. The problem was to tie this to long hydrocarbon chains, rather than vague 'non-polar groups'.

(b) (i) All recognised that the enzyme was being denatured at high and low pH, and that this involved a change in shape of the active site. Stronger candidates realised that the disruption of ionic bonding in tertiary structure was caused by changes in ionisation of R groups. Few knew that deprotonation of NH_3^+, rather than of COOH, was involved.

(ii) Few could name the product as sodium butanoate or butanoate ions. Butanoic acid was the commonest incorrect response. Soap was not accepted.

(c) Most suggested, in some way, that tristearin was the wrong shape to fit into the active site. 'Specificity' alone is too vague.

(d) (i) This was the easiest mark on the paper. Only a handful took the inhibition as being non-competitive.

(ii) The majority focussed correctly on similar groups, such as ester (including C=O) or hydrocarbon/alkyl chains. Few went on to suggest the type of attraction that might bind these to the active site.

(e) Hydrolysis or breaking down of fats or lipids were equally acceptable. Many candidates were too vague or unscientific in their response. A few weak candidates suggested that protein or starch stains were being broken down.

Question 4

(a) About three quarters of the entry wrote 'sequence'.

(b) Only half the candidates were successful in drawing C=O - - - H–N where the C and N atoms were clearly part of the main chain. In too many cases, others implied that R groups were involved. A minority wrote down all they knew about tertiary interactions, perhaps hoping that something would be right.

(c) (i) Most candidates found peptide (accepted) or amide links, or noted the repeating CCN backbone.

(ii) Only the better candidates mentioned the absence of N–H groups.

(iii) A good number scored 1 or 2 marks for spotting that the R groups were attached to N rather than to C, or that there was an absence of chirality in the synthetic polymer, or that there was a lack of variety of R groups in this compound. Some suggested wrongly that real proteins do not contain benzene rings in their R groups. Phenylalanine and tyrosine do.

(iv) A good number suggested van der Waals' forces or dipole–dipole, but most were then too vague in describing the groups involved. Benzene, alkyl or ether would have done well. As in (b) many weaker candidates simply listed all possible tertiary interactions usually found in proteins with no reference to the structure of the synthetic polymer.

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. Calculations were performed well by a large proportion of candidates.

Comments on Individual Questions

Question 1

This question was well answered by the many of the candidates.

(a) (i) This caused some candidates to lose marks through giving alternatives such as partition or adsorption rather than just one of these.

(ii) This was very well answered by the majority of candidates and in (iii) most candidates were then able to apply their knowledge to a real example and identify the second spot up as having an R_f value of 0.2

(b) This was less well answered.

(i) A significant proportion of candidates were able to identify that component **A** was the most volatile since it was detected first or that it was the component that spent the least time before being detected.

(ii) This was caused some difficulties even for reasonably able candidates. Firstly candidates needed to identify that it was the area under the peak that needed to be calculated. There were a number of acceptable ways to do this whether that was measuring with a ruler, using the scale from the axes on the graph or counting the squares of the grid.

Question 2

This question was well answered by a significant number of candidates.

(a) (i) Most candidates identified carbon-13 as being responsible for the M + 1 peak.

(ii) Candidates were able to calculate the number of carbons well. Those candidates who did not show their use of 1.1 and so rounded an answer of 4.4 to equivalent to 4 carbons with no reasoning did not score full marks.

(iii) Many candidates were able to deduce the correct molecular formula of C_4H_6O and a significant number were able to show their reasoning. Weaker candidates were those who fond it difficult to show that from the mass spectrum the M_r was 72 and so there could only be one oxygen atom present since part (ii) had shown there were four carbon atoms.

(b) Candidates were not always able to use the information from part (a)(ii) about the molecular formula of **D** together with the information in the question for (b) to determine the structural formula of **D**. It is important that candidates remember the difference between molecular, structural and displayed formulae.

(c) A significant number of candidates answered this question correctly by saying that a chromophore was a structure that absorbs uv/visible light. Those candidates who merely stated what these structures could be were just restating the question. Candidates should make sure they are answering the question that has been asked rather than one they think they would like to answer or one that they have perhaps seen before.

(d) This question was well answered and many more candidates have answered in terms of the light being absorbed being within the visible range. Some candidates still answered by saying that the chromophore makes 'it' be in the visible and this is not a correct response.

(e) It was evident that many candidates had performed calculations like this on many previous occasions and so there was a significant number of correct answers. Those candidates who struggled were those who could not remember the relationship between the speed of light, wavelength, Planck's constant and energy or those who were less confident with conversion of nanometres to metres, even though the conversion was given in the question.

Question 3

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

(a) The majority of candidates identified restriction enzymes that are used to cut DNA into fragments.

(b) (i) Most candidates scored 1 mark here by either stating that a DC current/voltage is applied or that the process is carried out in the presence of a buffer solution. However, very few candidates scored the second mark of saying that the fragments are all negative or that the fragments are all attracted to the anode. In fact a large proportion of candidates suggested that the fragments were separated by moving towards the oppositely charged electrode and that both positive and negative fragments would be present.

(ii) A significant number of candidates were able to identify both the charge and mass of the fragments to be the factors that determine how separation happens.

(c) Candidates were able to describe the role of phosphorus in the process, indicating that it is radioactive, that it attaches to specific parts of the DNA fragments and that it causes fogging of the X-ray film. Weaker candidates were those that struggled to express knowledge in a clear way.

(d) A very large proportion of candidates were able to identify the bands in F1 that flagged this as being the father of the child.

Question 4

(a) Candidates were able to identify both similar and different peaks within the infra-red spectra of **X** and **Y** but found it more difficult to do the same for the mass spectra. In the infra-red the common absorbances were those for the C=O bond, C–O bond and O–H bond whilst **Y** has an absorbance for N–H that **X** does not. Whilst in practice this absorbance would be masked by the O–H absorbance, credit was awarded for candidates identifying this difference in structure and the relevant troughs formed within the spectra.

The mass spectra had a large number of peaks that would have been produced by similar and different fragments. Common ones were the $COOH^+$ group at 45 as a similar peak and the $H_2NCCH_3^+$ at 43 as a different peak. Few candidates were able to identify that the M:M + 1 ratios would be different for **X** and **Y**.

Many candidates were very imprecise and inaccurate in their terminology within this answer even though the quality of use and organisation of scientific terms was assessed here.

(b) Most candidates were able to identify the correct chemical shift ranges from the data booklet. However a significant number were unable to deduce the splitting patterns and relative peak areas for the three different chemical environments.

2815/06 Transition Elements

General Comments

Candidates performed well on this paper. There were many high scores and few candidates for whom this examination was inappropriate. Most candidates attempted to answer the questions set and there was no evidence that time was a factor.

Centres have worked hard at correcting common mistakes made by candidates in the past. Most candidates now use an appropriate 3-D convention to represent stereoisomers. It is particularly pleasing to see that visible spectra no longer cause candidates the problems encountered in the past.

Calculations and balanced chemical and ionic equations continue to be a weakness for many candidates.

Comments on Individual Questions

Question 1

This question was a good starter and enabled most candidates to score good marks. Diagrams were almost always 3-D. The use of ethane-1,2-diamine did cause some problems, the most common being that candidates treated it as monodentate and ended up drawing diagrams that were tetrahedral or square planar. Many candidates now understand the information provided by a visible spectrum and can discuss colour at length.

Question 2

Very few candidates could explain how chromium in a steel alloy prevented the iron from rusting. The common answer was to treat the question as chrome plating. The dichromate/chromate equilibrium caused many problems. Only the more able candidates were able to explain the addition of acid moving equilibrium to the left. In part (d), candidates scored 1 mark for obtaining the 1:3 ratio but often failed to gain the second mark because the equation was not balanced. A common mistake was to leave electrons on both sides of the equation.

Question 3

Candidates lost marks in (a) by not realising that it is an emf that is being measured. Many candidates omitted the standard conditions. In (c), many candidates calculated the M_r correctly but then could not work out the mass of 0.1 moles. Part (d) proved to be very difficult with only top candidates providing a suitable answer.

Question 4

Candidates clearly know the chemistry of vanadium. Marks for the formulae and colours of the aqueous ions are well known although a number of candidates gave examples that were not ionic, particularly for the +4 and +5 oxidation states, *e.g.* VO_2 and V_2O_5. There was some confusion about the redox reactions of the vanadium ions with zinc and with manganate(VII) ions. Weaker candidates lost marks because they could not balance the equations. Perhaps they were unwise in their choice of example as it was seen to be much easier to balance redox equations involving the +2 and +3 ions. Many candidates provided in-depth knowledge of the use of vanadium(V) oxide in the Contact Process when all that was required was the formula or name of the catalyst and a balanced equation for the oxidation of sulphur dioxide to sulphur trioxide.

2816/01 Unifying Concepts in Chemistry

General Comments

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

There was a wide range of marks and there were no questions where candidates failed to score. The question on reaction rates proved to be more difficult than previously, perhaps because two variables had been changed in the initial rates problem.

The truly synoptic Question 4 contained fewer calculations that has been the norm and proved to be the most difficult question on the paper. The question discriminated extremely well.

Comments on Individual Questions

Question 1

(a) (i) A standard definition was required, which presented no problems.

(ii) The associated ‘simple’ calculation was, surprisingly, rarely answered correctly. Candidates focused on the stoichiometric relationship from the equation, rather than simply subtracting the partial pressures given from the total pressure to obtain the correct value of 488.6 kPa. The commonest incorrect partial pressures seen were 3.8 kPa, 481 kPa, 125 kPa and 11.4 kPa.

(b) The expression in (b) was usually correct and the calculation, marked consequential on their answer to (a), scored full marks in the majority of cases. Because of the problems with part(a)(ii), the examiners saw many consequential answers that were credited. The correct answer was 2.23 kPa^{-2}.

(c) This part was unstructured and was therefore more demanding. Most answers earned some marks, but few earned full marks. The most common errors were to ignore (or not explain) the effect of increased pressure on rate and to not use K_p to explain the effect of temperature on the equilibrium.
Most candidates were awarded the mark for Quality of Written Communication.

Question 2

(a) This part started with a variation on the initial rates method of determining the order of reaction. Most candidates could deduce the first two orders with ease, but the last one had two variables, and this proved testing, with only the best candidates earning full marks. The other parts of the calculation were again marked consequentially and produced few problems. The correct answer was 0.149 $dm^6\ mol^{-2}\ s^{-1}$, with responses to either two or three significant figures being accepted.

(b) This part was universally well answered, although some responses omitted the ‘initial’ part of the rate.

(c) This part was less well answered; candidates do find the link between the stoichiometric and rate equations to be a difficult concept, even in this easy context.

Question 3

(a) This was a very easy opening part with virtually all candidates securing the mark by commenting on partial dissociation.

(b) It was refreshing to see the majority of candidates responding with the correct answer of NO_3^-.

(c) After the easy introduction to the question offered by parts (a) and (b), this part proved to be far more testing. Most candidates managed to obtain CO_2 and H_2O as products for the first reaction but many were unable to then balance the equation. The second equation proved to be more difficult with H_2O often seen as the second product rather than H_2. Many candidates incorrectly produced CH_3COOMg as the salt.

(d) (i) This was well answered with the majority obtaining the correct answer of 0.176 mol dm^{-3}. Surprisingly some candidates read off 44 cm^3 as the volume of NaOH(aq) for neutralisation, presumably as the total volume of the alkali added.

(ii) This was very easy with most identifying correctly metacresol purple from the vertical section of the titration curve.

(e) The examiners were extremely impressed with the responses to this part with many answers earning full marks for the correct pH value of 2.20. Many other candidates made only one slip in their working and this usually lead to a mark of 5 out of 6. The commonest mistakes seen were confusion between ethanol and ethanoic acid and a failure to scale up the molar quantity of ethanoic acid to obtain the concentration in mol dm^{-3}.

(f) Many candidates now understand how buffers work, and the answers to part (f) were better than they have been in the past. Some candidates still think that sodium hydroxide is the base in the buffer solution, and that it does not react with the ethanoic acid, but neutralises any other acids added to the buffer. Unfortunately there were still some ill-prepared candidates taking this paper who had not learnt this topic. Such candidates found it difficult to score any marks.

Question 4

(a) There were only a few correct answers seen to this part, with many candidates gaining only one mark for using 1.8%. Possibly the unusual context made it difficult to spot the simple molar ratio. The correct answer was 5.18 tonnes.

(b) There were many ‘correct, and imaginative, attempts at the equations in this part, although adding the two steps to get an overall equation was surprisingly difficult for many candidates. Unfortunately, S_2 was often seen in equations to represent sulphur.

(c) This part was well answered and proved to be the easiest in this question; oxidation numbers are well understood.

(d) This part was testing, with few correct equations seen in this unusual context for conjugate acid–bases. Some very good candidates rose to the challenge and produced the correct products, HCO_3^- and HS^-.

(e) Most candidates were able to show the structure of the thiol although some confused but- with prop-. The requirement for an equation proved to be more testing but most candidates at least made an attempt. The commonest correct approach was to use Na with production of a salt and hydrogen. There were many approaches possible with esterification, combustion and oxidation often being seen (albeit, often with incorrect products). Unfortunately many candidates close to use NaOH and this would produce no reaction.

2816/03 Unifying Concepts in Chemistry (Practical Examination)

General Comments

As usual, the number of candidates entered for this paper was small. The Plan and Evaluation parts of the Test were slightly easier than usual, but the Implementing and Analysis section proved somewhat more testing.

Comments on Individual Questions

Plan

A

The Plan proved to be straightforward for most candidates. As usual the mark scheme had 19 marking points, so a large number of candidates were able to achieve the maximum mark of 16.

The manganate(VII) titration was described very well by most candidates. A few omitted to acidify the iron(II) salt solution prior to the titration, while some others thought that this titration needed to be heated in order to work. The calculation of the result from specimen data discriminated well, because weaker candidates were usually not able to show the necessary working clearly or forgot to ‘scale up’ in their calculation to allow for the volume of solution in the volumetric flask.

The gravimetric experiment was also described very well by most candidates, even though this is less familiar as a practical technique. It was good to see that many candidates had researched suitable accuracy precautions, such as washing the residue on the filter paper with water and then drying to constant mass.

Test

B

Part 1

The standard of accuracy achieved by most candidates in this titration was very high, despite its relative complexity: a majority of candidates was able to score all 7 marks for accuracy. A few candidates failed to show all burette readings and some omitted relevant units with their data.

Part 2

The easier part of the calculation on page 4 was done well. However, the more demanding work on page 5 proved to discriminate well. Few candidates were able to explain convincingly why the oxidation state of carbon went to +4. It was disappointing that a number of weaker students were unable to identify the oxidation states on manganese in (d)(ii). Identifying carbon dioxide in (e) also proved demanding.

Part 3

This exercise proved very difficult. Some more able candidates understand the concept of a precipitation reaction and were able to give a correct ionic equation, but few were able to give the salt name derived from ethanedioic acid. ‘Carbonate’ and ‘dicarbonate’ were often suggested.

Part 4

The Evaluation proved to be slightly easier than usual. However, the standard of answers in (a) to a qualitative question on kinetics proved somewhat disappointing. Only a minority mentioned activation energy in their answers. The question in (b) was answered quite well and (c) proved to be easy marks for the majority. In (d) most candidates were aware of the fast that acid is used in excess, though some framed their answer in terms of catalysis. Answers to (e) were pleasing. Most candidates appreciated that the brown colour would mask the end-point and a significant minority realised that production of MnO_2 would give incomplete reduction of $KMnO_4$.

Grade Thresholds

Advanced GCE Chemistry (3882/7882)
January 2008 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	46	40	34	28	23	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	48	42	36	30	25	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	98	88	78	68	59	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	98	88	78	68	59	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	93	83	73	63	54	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	71	63	56	49	42	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	70	63	56	49	42	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	74	66	59	52	45	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	73	66	59	52	45	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	98	87	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	98	87	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	94	82	71	60	49	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	11.7	35.0	56.6	79.7	95.8	100	556
7882	18.4	51.2	74.1	89.6	96.0	100	212

768 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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