

GCE

Edexcel GCE

Chemistry (8080/9080)

This Examiners' Report relates to Mark
Scheme Publication code: UA017774

Summer 2006

Examiners' Report

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information please call our Customer Services on 0870 240 9800, or visit our website at www.edexcel.org.uk.

Summer 2006

Publications Code UA017774

All the material in this publication is copyright

© Edexcel Ltd 2006

Contents

Unit 6241/01	Page 1
Unit 6242/01	Page 4
Unit 6243/01 (Coursework)	Page 8
Unit 6243/01A/01B/01C (Practical Test)	Page 12
Unit 6243/02	Page 14
Unit 6244/01	Page 19
Unit 6245/01	Page 23
Unit 6246/01 (Coursework)	Page 26
Unit 6246/01A (Practical Test)	Page 29
Unit 6246/01B (Practical Test)	Page 31
Unit 6246/01C (Practical Test)	Page 33
Unit 6246/02	Page 35
Appendix A (Statistics)	Page 39
Appendix B (Candidate Record Sheets)	Page 41
Appendix C (Online Marking (ePEN))	Page 43

6241/01

General

This paper contained some relatively straightforward questions, along with a number of more demanding ones. The most common reason for loss of marks, apart from inadequate knowledge, was a lack of precision in explanations. There were no signs that candidates experienced time pressure.

Question 1

In (a) the electron configuration was usually correct, with occasional examples of the mass number being used to generate spurious patterns.

The better candidates correctly identified a large increase in the 5th ionisation energy in (b), though it was not uncommon to see a large increase in the 4th ionisation energy proposed.

The diagram in (c) was usually correct, with the omission of the chlorine lone pairs being the common error.

The workings of the mass spectrometer in (d) were well understood and explained. Candidates sometimes failed to refer to removal of electrons from the sample in (i).

The definition in (e)(i) was often well stated, though a considerable number of candidates defined relative atomic mass instead. The calculation in (ii) caused few problems, though some candidates used averaged mass numbers. The majority of candidates displayed a clear understanding of the nature of isotopes in (iii) and (iv). Weaker candidates sometimes stated that isotopes have the same chemical properties due to their identical proton numbers.

Question 2

The great majority of candidates had no difficulty in (a)(i) and (ii). The better candidates often scored full marks in (iii) for simple, clear explanations. Weaker candidates struggled to present coherent statements, and it was fairly common to see reference to breaking covalent bonds.

The importance of delocalised electrons in metallic bonding was generally well known in (b), though metal atoms were often referred to rather than ions. The strong attraction between the ions and electrons was frequently absent.

The ionic bonding in (c) was very well known. Convincing diagrams showing the three-dimensional structure of sodium chloride were frequently seen, though sometimes atoms were shown, or just a single layer of particles.

Question 3

The flame colours in (a)(i) were extremely well known. Occasionally 'orange' or 'green' were given for calcium. The explanation in (ii) was often fully correct. Sometimes electrons were said to be moving between 'different' levels, and sometimes they fell to a lower level, without any initial promotion. Some candidates made no reference to electrons at all.

The equations in (b) presented little difficulty to the better candidates. Weaker candidates were often insecure with respect to the formulae of the sodium compounds, and indeed to the products of the reactions.

The observations in (c) were well known and stated, and it was common to award full marks here.

The majority of the candidates knew the formula of potassium superoxide in (d), though occasionally KO_3 , KO , K_2O , K_2O_2 etc were offered.

Question 4

In (a)(i) the oxidation numbers were very often correctly stated. The common error was to give '-2' for the halides. Better candidates were usually able to correctly use their oxidation numbers in (ii) to explain the redox nature of the reaction. The common error was to answer in terms of electron transfer, contrary to the requirements of the question. The calculations in (iii) and (iv) were generally very well done, the only recurrent error being the use of 127 as the molecular mass of iodine in (iii).

The descriptions of iodine in (b)(i) were usually correct. Occasionally answers more appropriate to iodine solution were given. Better candidates could usually score full marks in (ii), though weaker ones often included molecular iodine, or omitted state symbols. In (iii) the idea of increased shielding was commonly correctly given. The increased distance between outer electron and nucleus was usually referred to, though not always with sufficient precision. Iodine's greater nuclear charge was often omitted from weaker candidates' answers.

Question 5

All of (a) was marked as a single part, to ensure that candidates gained credit for correct answers, whether they appeared in (i) or (ii). The number of electron pairs in the outer shell of oxygen was often correctly stated, though a significant minority of candidates offered three electron pairs here. The idea that the electron pairs would repel to maximum separation / minimum repulsion was often present, though not always precisely stated. Sometimes 'bonds' or 'atoms' were said to be repelling. The bond angle was fairly well known, as was the idea of lone pairs repelling more than bonding pairs, though this last point was omitted occasionally.

The diagram and bond angle in (b)(i) were usually correct. The common error was to include a lone pair in the diagram, and give a bond angle more appropriate to e.g. ammonia. The majority of candidates were successful in (ii) with an electronegativity argument, though some merely referred to the atoms bearing partial charges. Better candidates were usually successful in (iii), with the common incorrect attempt being that 'polarities cancel'. It was very common to award the mark in (iv), with 'dipole forces' as the only regular incorrect response.

The vast majority of candidates were able to achieve full marks in (c). Sometimes atomic numbers were used in the calculation, and sometimes a formula was not actually stated, despite a correct calculation.

Hints for Revision

- Memorise all the required definitions.
- Make sure you fully understand the factors that influence the melting points of different substances.
- Learn the reasons for the trends in ionisation energies in the Periodic Table.
- Ensure that you understand the reasons for the shapes and bond angles of molecules with lone pairs.
- Make sure that you can clearly explain why bonds and molecules may be polar.

6242/01

General

The paper gave many candidates opportunities to show what they knew, and there were some high-scoring scripts. Conversely there was a sizeable minority who seemed to have learned by rote or by answering past papers, since some of the questions they answered had appeared in previous papers but not this one.

The paper successfully distinguished in places between those candidates who had learnt the material but did not understand it, and those who had managed both. This was particularly evident in Question 3 on reaction kinetics where numerous candidates were perfectly happy to label the horizontal axis of the Maxwell-Boltzmann distribution as, say, time - and then to mark on it a value for the activation energy.

Numerous examiners commented on a marked deterioration in presentation, for the first time for a number of years. Some candidates do not seem to think that legibility matters or that the coherent arrangement of a calculation is an aid to its understanding. There were also several comments regarding poor quality of written communication, candidates sometimes being unable to make themselves understood even in single sentences.

This paper was marked on-line; most papers in this specification are. On-line marking is monochrome, and whilst examiners have sympathy for the use of colour especially when dealing with the Maxwell-Boltzmann distribution, the fact is that red and pink do not show up at all and other colours cannot be distinguished. Such answers are of course pulled and marked conventionally, but it would be advantageous if candidates developed the ability to distinguish lines or areas on graphs in some other manner. Pencil is not a suitable alternative to the use of colour.

Question 1

Apart from a minority of very strange answers all candidates knew that sodium hydroxide and cryolite are involved in the extraction of aluminium. Cryolite was frequently mis-spelled. Most also knew that the melting temperature of alumina is very high, precluding the use of the molten compound in the electrolytic cell, but those who simply said that it would be too expensive did not score. There was a surprising amount of confusion between melting and boiling temperatures.

The half-equation for the cathode reaction was well-known. Concerning oxidation of the anodes, candidates usually said that they are carbon and that oxygen liberated at the anode caused the production of carbon dioxide. A few said that oxide ions reacted with the anode; some that oxygen from the cathode reacted with the anode. A significant minority failed to give an equation even when it was clear that they would know what it is.

Uses of aluminium were usually well-known, with aircraft manufacture being the favourite. Low *density* was required as a reason - 'light' was not allowed.

Question 2

Large numbers of candidates knew the structures of the three alcohols and their oxidation products. Too many drew the molecules very carelessly and sometimes paid little attention to valencies, so that the carbonyl group on butanone often had a spurious hydrogen atom on the carbonyl carbon. There were also too many hydroxyl groups attached to carbon through hydrogen, OH-C. Such structures receive no credit - the bond goes to the oxygen. A large minority started the question without having a clear idea in their head about the layout of the formulae on the page, made several attempts with much crossing-out, and demanded a good deal of ingenuity from the examiner in finding out what they meant. For full credit it was necessary to say that the tertiary alcohol does not oxidise under the stated conditions, or that no new product is formed; a line in the box was not enough.

An astonishing number of answers to 1-iodopropane missed out the "1"; very few knew that red phosphorus and iodine must be moist, many asserting it must be dry. However, many offered PI_3 or PI_5 (which was allowed) as the halogenating agent.

The conditions for the reaction of 1-iodopropane with cyanide ions often had 'heat under reflux', and examiners had a feeling that this was possibly a reflex response. Many fewer knew that ethanol or aqueous ethanol is the solvent. The structure of the resulting nitrile was often correctly given, though $\text{C}_3\text{H}_7\text{CN}$ was not accepted since it is ambiguous. A large number of candidates knew that the reaction is nucleophilic substitution.

Question 3

This question distinguished clearly those who understood that reaction kinetics deals in the number of successful collisions *per unit time*, and those who did not; and between those for whom the Maxwell-Boltzmann distribution is a description of a real physical system and others for whom it is simply an arrangement of lines on paper.

Everyone knew that the large surface area of powdered manganese(IV) oxide mattered, but relatively few said that this increased the chance of molecules colliding with the surface or that the collision frequency increases. Many erroneously said that 'more molecules have the activation energy' and thought that they had addressed the problem.

The drawings of the Maxwell-Boltzmann distribution were highly variable in quality. Essentially the curves should be skewed and become reasonably asymptotic close to the energy axis. Some rather stylised graphs became horizontal 1 cm or more above the energy axis, which will not do. A substantial number of graphs had unlabelled or wrongly labelled axes, and a few did not distinguish the T_1 and T_2 curves at all. The problems associated with use of colour have been mentioned (and apply equally to the shading needed in (ii) and (iii)); the curves should be labelled directly, not colour-coded.

Many candidates showed a sensible value for E_a , which should be well to the right of the modal peak. Using some quantity other than energy along the x-axis did not deter candidates from marking their vertical line as E_a , showing a rote view rather than understanding. Some gave sound explanations relating the increased rate at T_2

to a greater area under the curve, clearly identified, and recognised that a *greater proportion* of the collisions are successful. Too many said, incorrectly, that ‘more of the collisions are successful’. A large number did not directly relate their ideas to the curves that they had drawn, and either made no attempt at any shading, or did shade but made no explicit reference to it. Such candidates would often say ‘as you can see from the graph...’, without making clear what it was the examiner was supposed to see. Examiners are not in the business of second-guessing candidates’ intentions.

Many drew in a suitable E_a line for the catalysed reaction, but then failed to capitalise on the diagram and made no reference to it. Routine definitions of what a catalyst is were quite common.

Question 4

Numerous candidates scored two of the three marks when defining standard enthalpy of formation. The two common errors were to omit to say that the elements need to be in their standard states, or to fail to say what standard conditions actually are.

The results for the value of ΔH for the dissociation of PCl_5 fell roughly equally into endo- and exothermic values. Very few candidates showed what they were thinking, and most simply wrote down numbers. In explaining the effect of changing the conditions under which an equilibrium exists candidates often give the reaction mixture the ability to think - ‘the equilibrium wants to move to the right’ - or fail to recognise that the two temperatures or the two pressures are *equilibrium* values. Thus many knew that raising the temperature of the equilibrium in the question would increase the amount of PCl_3 and Cl_2 since the forward reaction is endothermic; however a distressingly large minority also said that this would bring the temperature down again. It had not occurred to them that the two temperatures are imposed from outside the system. A few candidates use ‘temperature’ to mean ‘an increase in temperature’. Most knew that an increase in pressure would fit the bill in increasing the amount of PCl_5 in the equilibrium mixture and could say why; once more some thought that the pressure would then be brought down again.

Examiners sense that too many candidates see equilibria as the manipulation of symbols on paper, and that too few have a real physical feel for what is going on in an equilibrium system.

Question 5

The majority of candidates were able to calculate the empirical and molecular formulae for W, though with variable degrees of competence in laying the calculation out comprehensibly. Many fewer knew that ethane-1,2-diol was then expected, followed by 1,2-dibromoethane for W. Some very bizarre compounds were suggested, including some with covalent bonds to potassium. Such candidates, too numerous for comfort, had no picture of what is happening in the reactions.

The essential focus for the rate of hydrolysis of primary halogenoalkanes should have been on the carbon-halogen bond strength and the activation energy for the hydrolysis. Candidates who explicitly considered this did well and could explain why the bond length and hence strength gave the observed results. It was rare for

the activation energies to be considered explicitly. However other candidates talked vaguely about the 'bonding in RCH_2X ', and a sizeable minority answered in terms of bonding in the hydrogen halides or even the halogens themselves. These latter answers usually went into routine mode about trends in group 7, and did not address the organic chemistry at all.

Question 6

The solution of sodium chloride used for the membrane cell has to be concentrated, and candidates were expected to say so. Surprisingly very few did, so what was thought to be an easy starter turned out otherwise. Many candidates knew the electrode reactions - the commonest error was to produce sodium at the cathode. There was also widespread understanding of chlorine's uses.

The role of the membrane was very poorly understood. A large number of candidates mentioned 'asbestos', so were thinking of the diaphragm cell, and many simply regarded it as a barrier to prevent substances mixing. Those who did move towards the membrane idea talked about 'semi-permeable' membranes that filtered ions or molecules on the basis of size. Very few knew that the (Nafion) membrane is specifically a cation transport membrane, and will transfer any cation. It will not transfer anions.

The structure of the repeating unit of PVC was widely known.

Many candidates knew that PVC is useful because of its resistance to chemical attack, particularly hydrolysis.

Some candidates ignored 'by incineration' at the end of this question, and proceeded with their usual apocalyptic views on all manner of environmental disasters relating to the greenhouse effect or depletion of the ozone layer, or the lack of biodegradability of PVC. Of those who did know what was being asked, a large minority thought that chlorine was liberated on burning PVC.

Hints for Revision

- Learn definitions precisely; they are carefully worded and each word matters.
- Practise drawing organic structures carefully, paying particular attention to valencies.
- In everything you write about try to picture what is happening to the molecules as they react; the study of reaction kinetics and of equilibria is about real physical systems, not symbols on paper.
- Lay calculations out clearly so that the reader can see what you are doing. Think about the layout before you start to write.
- Answer the question that is in front of you, not the one that looks more or less the same as that which you saw several weeks previously in a past examination paper.
- Where a question requires extended writing, lay the necessary points out as a list in your head before you start to write.

6243/01 (Internal Assessment of Practical Coursework)

General

One of the welcome developments to this assessment scheme is that its implementation by centres has significantly improved over the past few years. The majority of candidates in the majority of centres have their laboratory skills assessed rigorously and fairly. Many of the issues that have concerned the moderators in the past no longer do so. For example this year the authentication statement on the record sheets (or cards) was properly signed and dated by both candidate and centre assessor for virtually the whole entry. Another gradual change has been that centres increasingly use exclusively the Edexcel assessment exercises. The moderators, however, have no objection to assessors using their own designed-exercises providing these are approved by the Principal Moderator in advance of their use by candidates. Edexcel regards the E9 (formerly U9) feedback document as an important part of the assessment scheme. It is vital that the E9 is read by the teacher in charge of Chemistry before the start of the autumn term. If the moderator has checked any 'no' responses on the E9 then a comment should have been added to explain the response. It is then expected by Edexcel that the issue raised by the moderator will be addressed by the centre and appropriate action taken. An example of this is the continued use of record cards by some centres in spite of repeated reminders to switch to record sheets. Presumably the centre assessor has never seen the E9 that instructed the centre to make this change or has chosen to ignore the moderator's comments.

A list of questions relating to both old and new issues follows. Any centre assessor who considers that he or she is operating the scheme perfectly may choose to use this as a checklist to which all the responses should be 'yes'.

- Have you read the 2005 Examiners' Report for 6243/01 - in particular the comments on how ability A, Planning, exercises should be carried out? Do you assess your candidates for ability A according to the procedure outlined in the 2005 Report?
- Have you read your 2006 E9 and taken action if necessary?
- Do you use record sheets and not record cards (no longer a valid Edexcel document)? [*The record sheets are provided as an appendix in this Examiners' Report.*]
- Does every candidate have at least one mark from an organic exercise included in his or her mark profile?
- Do you include in the sample to your moderator only the work of candidates asterisked on the OPTEMS (plus the highest and lowest scoring candidates if not already included)?
- Do you include for each candidate in the sample only the exercises for which the marks are included in the mark profile?
- Are the two ability B exercises in the mark profile based on different types of experiment - e.g. a titration and a heat change investigation?
- If you submit centre-designed exercises as part of your sample for moderation do you enclose evidence that they have been approved by the Principal Moderator since the revision of the scheme in 2003?
- Have you done everything reasonable to allow your moderator to follow your awarding of marks? Have you used at least one of numbered ticks, mark grids or ticks on a copy of the mark scheme?
- Have you included assessor values for ability B exercises so that the award of marks for accuracy may be easily tracked.

Comments on assessment of the abilities

Ability A Planning

This year the moderators continued to see word-processed plans; some with diagrams drawn with the aid of computer programs, and some with references to resource material taken from websites. Extensive comment was made on the conditions under which this ability must be assessed on page 9 of the 2005 Examiners' Report for Chemistry - the text is repeated here:

.....Listed below are a number of points that may clarify the way in which planning exercises should be carried out.

- It is likely that candidates will only have one or two opportunities to carry out a planning exercise. The most appropriate time for a planning exercise is soon after the candidate has studied the topic on which the exercise is based.*
- Candidates should be told in advance that they are to be assessed for ability A. They should be given details of the specification topic on which the exercise is based. For example if AS11 (Identification of Organic Compounds) is to be set then candidates may be told that they need to know and understand the relevant tests from Topic 2.2.*
- During the assessment exercise candidates must not be allowed to consult or copy from any notes or books. They should be supervised under conditions that are very close to those in written examinations. Candidates should be given a time limit for completion of the exercise.*
- If, in the assessor's opinion, candidates need more time than is available in one session they may be allowed to continue the exercise in a following lesson. When this happens the unfinished exercises must be collected by the assessor then returned for completion at the earliest opportunity.*
- Candidates should be reminded at the start of every assessment exercise that they will be asked to sign an authentication statement to the effect that any work submitted to Edexcel is their own and that they have received no help apart from that of their teacher. Moderators are instructed to report any suspicions they may have that candidates from the same centre may have colluded to Edexcel.*
- There is no requirement whatsoever to word-process a plan. If a word-processed plan is submitted to a moderator the centre assessor should include a note explaining the conditions under which the word-processing was carried out.*
- Once collected in, plans must not be returned to candidates for "corrections". If, in the opinion of the assessor, a candidate has under-achieved on a planning exercise then he or she may be given another opportunity to complete a planning exercise, but using a different assessment.*

Centre assessors should regard this as definitive. Any centre that fails to carry out the assessment of ability A in this spirit is liable to have the marks of its candidates questioned by the moderator. Moderators are under a strict instruction to forward any samples that may even raise a suspicion of unfair practices to Edexcel for further investigation.

The moderators do thank those centre assessors who obviously administer the planning exercise exactly as intended then mark it with numbered ticks and grids. There is no need to write any corrections on the work since it is not to be returned to candidates.

Ability B Manipulation

It is essential that the sample sent to the moderator includes the information that has been used by the assessor to award the marks for accuracy. The ideal way to show this is to write the expected value next to the candidate's actual value. For example, in AS6 the assessor should write the expected temperature rises and neutralisation volumes close to the candidate's recorded values on page 26. The differences between the two values may then be calculated and marks 4-9 awarded. The marks may then be transferred to the grid on page 74. Accuracy marks should be awarded on the candidate's own recorded values and not on values corrected by the assessor. Thus in AS6 there is no need for the assessor to re-plot the temperature-time graphs then to compare the corrected temperature rise and volume with his or her own values.

The moderators have been aware for some time that the scheme did not include a simple acid-base titration exercise. In order to address this, exercise AS15 has been added. Centre assessors can request a copy of AS15 complete with the mark scheme and Technician's Notes from the GCE Chemistry Assessment Leader at Edexcel.

Ability C Observing and recording

Some centre assessors are too generous in their award of marks for observations. Marks should only be awarded when the candidate's recorded observation exactly matches that in the mark scheme. The only exception to this is when the assessor is convinced that a colour named in the mark scheme is not the same as that actually seen in the test. Since coursework candidates also sit the written papers it is essential that centre assessors do not mislead candidates by awarding marks to chemistry that would not be accepted in the written papers. Some common examples of incorrect recording of observations are given in the table below.

Observations

Reaction	Acceptable recording	Unacceptable recording
A gas is evolved from solution	Effervescence or bubbles.	Gas evolved
A solid dissolves. e.g. AgCl(s) dissolves in ammonia(aq).	Colourless or a description of the colour, solution formed.	Clear solution
HCl is evolved	Steamy or white fumes or gas.	White smoke
A precipitate forms. e.g. AgNO ₃ (aq) + a chloride(aq).	White (or other colour) precipitate.	Cloudiness or white solution.
A colour change occurs. e.g. warming acidified K ₂ Cr ₂ O ₇ with a primary alcohol.	Describing the colour before and after the change. e.g. orange to green	Describing the colour only after the change. e.g. goes green.

Ability D Interpretation and evaluation of experimental results

Some centre assessors feel that it is unfair to ask candidates to make inferences from possibly inaccurate observations. They prefer to assess abilities C and D separately by first setting an observation exercise, collecting in the candidates' records, then supplying model observations from which candidates may make inferences. On page 10 of the 2005, 6243/01 Examiners' Report this procedure was said to be unacceptable. This comment still applies. When the scheme is revised the assessment of these two abilities may well be revisited but for now it is essential that all centres apply the scheme in the same spirit. This means that candidates must make inferences from their own observations.

Exercise AS12 includes a mistake on page 57 of Issue 3 of the Coursework booklet. Following test 3(b) the instruction to candidates should read as follows:

In the spaces below write your suggested formulae for the functional groups present in W, X, Y and Z.

This amendment was circulated to centres in a letter in September 2003.

Hints for carrying out coursework

- Describe a solution, as "colourless" not clear.
- Do not word process a planning exercise unless your teacher supervises you throughout. Do not use computer-generated diagrams.
- When you make up a solution in a volumetric flask make sure that you mix the solution before using it.
- Repeat a titration until you obtain consistent or concordant titres. There should be within 0.2 cm^3 of each other.
- Read thermometers and record temperatures to the nearest $0.5 \text{ }^\circ\text{C}$.

6243/01A, 01B and 01C (Practical Test)

General

The papers were constructed in a standard style, with candidates expected to complete a short qualitative exercise; two quantitative questions and to write a brief, non-executed plan. There was no evidence of a shortage of time and all questions were compulsory.

As is so often noted and commented upon in these reports, candidates often fail to heed the advice and information given in the rubric of the exam. This becomes most evident in the planning, although these problems are not restricted to this part of the examination. Candidates should be reminded that they are writing their answers for an examiner to read and hence be able to award marks to their work; this exchange should not presuppose that the examiner already knows what is in the candidate's mind. A similar problem arises when candidates insert an extra word into a sentence late in the exam. This can often completely change the meaning of the whole paragraph.

Question 1

This short qualitative exercise required candidates to carry out some standard test-tube reactions, and to make observations and draw inferences. The fact that this is an "open book" examination is as much a hindrance as a blessing, since too often too much information is copied from analysis schemes. This material seldom has a meaningful bearing on the compounds or reagents, and will always continue to be penalised. Candidates must also remember the need for clarity of expression too. Unthinking use of the word "it" will often lead to confusion. An instruction to heat strongly means just that, and candidates must recognise that in some cases a reaction only occurs under very forcing conditions. If a reaction has failed to be observed then the advice would be to repeat the test.

Question 2

The titration is the mainstay of the paper, and the overwhelming majority of candidates secure a high mark with the execution of this standard procedure. A few still failed to record a volume to 0.05 cm^3 , or made errors when completing the table. The calculations were generally well done. However candidates should think carefully about the number of significant figures they quote in their answers.

Question 3

This question used the exothermic nature of the neutralisation reaction between an acid and an alkali to furnish data for candidates to plot. From the straight line graph the gradient enabled an estimate of the enthalpy change to be measured.

There were many good answers, with a large majority obtaining data that translated into good straight lines when plotted. Some candidates lost marks through careless plotting, particularly for the points that were deliberately chosen to lie off the principal lines on the grid. Some candidates seemed to have been ill-equipped for the examination, with a variety of objects

apparently being used to draw a line. If the ruler was not 30 cm long then the line was drawn in two stages with the inevitable kink part way along. This did not make calculating the gradient easy, or meaningful.

The calculation of the gradient required candidates to mark on their plot to show how their figures were extracted from the graph. Many did so but too many failed to answer this part of the question and were penalised accordingly. Many candidates talked of “rise” and “step” presumably reflecting current idioms in mathematics. The final value of the enthalpy change was determined by substituting into a given equation. A minority failed to include the final negative sign, despite it being given in the equation. This carelessness will continue to be penalised.

The volume of solution needed to finally complete the question was stated correctly by the majority. Those who failed made the question far too complicated by trying to work with ratios and so forth which rapidly became too involved and led to the answer being abandoned.

Question 4

The planning question is perhaps the one that suffers most from this being an “open book” examination. There was evidence that candidates had pre-prepared answers, only to copy these out from their notes without checking too carefully whether they matched the actual question on the paper. As is usual with “identify these solutions” types of questions, many candidates started on the wrong footing by using statements that assumed prior knowledge of what the solutions were e.g. “take the acid”. A significant minority confused “enthalpy change” with “temperature change”.

Hints for Revision

- Remember that clarity in language is essential, if ambiguity is to be avoided
- Check that the inferences are meaningful in the light of the compounds that are given
- Examine the number of significant figures in an answer, and quote the final answer appropriately. Remember that a calculator will not do this for you, and an answer in the display of 0.1 may need to be quoted as 0.100
- Take the necessary drawing equipment into the exam so that graphs are well drawn
- Write a plan as if you are writing a procedure for another member of your class to follow.

6243/02

General

This paper required candidates to think about the implications of practical techniques as well as the interpretation of results from practical experiments. The examiners saw many examples of excellent work, particularly in the area of calculations. The major reason for loss of marks, apart from lack of chemical knowledge, was the inability of candidates to read the questions carefully enough. Many seem to read only key words and then start writing, failing to take in the detail and implication of the question. In the wording of questions the examiners try to help candidates to think in the right direction. Candidates should be taught to check their answers and make sure that they satisfy the actual question being asked.

Question 1

In (a) most candidates identified the gas evolved as ammonia and the associated cation as the ammonium ion. However those who opted for the name rather than formula for the ammonium ion made a wise choice. NH_3^+ was a common error. Other errors included 'aluminium' as the cation. The anion in the compound was usually identified as sulphate but again the formula eluded some candidates. Sulphite, carbonate and chloride were common wrong answers. The question clearly asks for the formula of the compound, many chose to write the name and did not score. There is very little the examiners can do if candidates choose to ignore the question.

Many candidates achieved 3 or 4 marks on (b). Most candidates were able to identify the cation (sodium) and the gas (oxygen). Candidates were less confident about the anion in the residue with nitrate being a common error. A sizeable proportion of candidates who had correctly identified the elements present, then went on to ignore the oxygen and suggest the compound was sodium chloride. This is an example of the failure to check the information before finalising the answer. The question clearly states that the compound contained three elements. It is difficult to see how NaCl satisfies this criterion. Many candidates identified the final compound correctly as a chlorate. Marks were often lost because of poor understanding of terms with Cl or chlorine often written instead of chloride and Na or O given rather than Na^+ or O_2 .

Question 2

The examiners saw some excellent and concise answers to this question that showed good knowledge of the chemistry involved and its application to the problem set. However, the question proved challenging for many candidates, large numbers of whom were let down by their inaccurate use of language. Many candidates were able to identify the correct chemical tests but the way they linked them together meant that the chemistry broke down. Many answers took no notice of the information given in (b) about the physical state of the compounds.

In (a) candidates were given the two gases and asked to state tests that would allow them to be distinguished. Most candidates scored well on this part. Some went into detailed discussion about how the gases would be generated. This was ignored by the examiners. The identification of sulphur dioxide proved a problem for a minority of candidates. Some relied on the litmus test, which would also work for carbon dioxide, or the smell which was identified as that of 'rotten eggs', while

others used litmus paper dipped in potassium chromate(VI). The use of the acidified chromate(VI) or potassium manganate(VII) was generally suggested but the colours were sometimes confused or reversed. Thus chromate(VI) went colourless.

Part (b) was much less well done. This was an open ended question. There were many ways the problem could be tackled and the mark scheme allowed for any valid test that distinguished between the carbonate and hydrogen carbonate to be credited. The best candidates thought about their answer and dealt with the problem in a few lines. However, answers such as add a solution of calcium ions; the carbonate gives a white precipitate; the hydrogen carbonate only gives a white precipitate after heating, were rare.

The question stated that the candidate had to propose a method to distinguish between two solutions, one of sodium carbonate and one of sodium hydrogen-carbonate. It was not clear why so many candidates added dilute hydrochloric acid and proved carbon dioxide. While not wrong this was the root cause of many wrong answers. Most candidates failed to make it clear that any further tests were carried out on a fresh sample of the solutions. Thus acid was added followed by calcium chloride or in some cases the measurement of pH. Many potentially correct answers did not receive full credit as the answer did not indicate that the group 2 compound was in solution or, if another route was chosen, how the pH would be measured.

Some candidates were able to give precise details of pH and colour changes for the hydrogencarbonate, but many gave a list of two or three possible tests without the precision required to score the marks. For example many wrote about heating the solids. While heating was a possible way through the problem, no mention of solids was made in the question. A small number of candidates suggested that acid could be added to the hydrogencarbonate and the hydrogen evolved then tested.

Question 3

The calculation part of the question produced high scores for most candidates, showing the continued improvement by candidates on calculation questions.

Part (a) of the question was overwhelmingly the worst answered part of the whole paper. Very few candidates were able to tie up their knowledge of halogen chemistry - properties of halogen hydrides - with their understanding of volumetric analysis techniques and realise weighing a gas to make a standard solution might just be difficult. A majority said that HCl was a gas but took their answer no further. Included among the range of suggestions were, HCl is not soluble in water, HCl is too dangerous to use, it is a solid that reacts violently with water, it would contain impurities or explode in water.

Part (b) required candidates to think about how a standard solution would be made up and what was wrong with the technique described. Many realised that the solid would alter the volume of the final solution and scored the mark. Those who failed to appreciate this got involved in complex arguments such as, no water would be available to wash the apparatus, solid might be left in the neck of the flask, solids dissolve better in smaller volumes of water(!), not all the solid might dissolve, uneven distribution of carbonate through the solution, or liquid might be lost on shaking.

The calculation in (c) presented little difficulty to most candidates. Many showed an understanding of the need for concordance between two titres most expressing it as the need for the two titrations to be within a small difference range. Examiners expressed concern with a minority of candidates who chose titrations 1 and 3 saying titration 2 was inaccurate since it did not start at 0.00. Others suggested that 31.10 and 30.30 were closer than 30.50 and 30.30. These candidates often went on to find a correct mean which they then used in the rest of the calculation and scored full marks. A small number of candidates identified the correct pair for use in the calculation and then averaged all three values.

Errors in the numerical part of the calculation were few. Some tried to work in dm^3 (very reasonable) but got confused at the end and achieved answers that were 1000 times too small or too large. Main errors involved units in (iii) and (iv), moles dm^{-3} instead of moles. Most marks were lost in the final part where the understanding of significant figures was tested. Far too many candidates thought that 0.08 or 0.082 were answers accurate to three significant figures. The final figure at the end of this question also illustrates the need to think about the answer at the end in the context of what is being done in the experiment. Titrations involving homeopathic concentrations of HCl or 50 mol dm^{-3} HCl might just be unreasonable answers in a school laboratory context.

Question 4

This question was based on the idea that the accuracy limitations of apparatus available in the laboratory could lead to some uncertainty in the final result. The answers to (b) were generally excellent but those for (c) proved to be good discriminators. Many candidates seemed not to have read the introduction which states that the compound is a metal carbonate and the equation which clearly shows the valency of X to be 2. Cs seems an inappropriate answer yet was a common error.

In (a) the majority of candidates understood the reason behind the need to heat to constant mass but many found it difficult to express this understanding clearly. It was necessary for candidates to explain that the constancy of mass showed the reaction was complete or finished. Common errors included statements that contained the words 'combustion' or 'burning' or talked about the need to remove any moisture.

Most candidates were able to score well on (b) of this question. A small number had difficulty in subtracting 3.55 from 5.75 or calculating the molar mass of carbon dioxide. Some candidates wanted to involve Avogadro's Constant at this point. Most of the errors seen were in (iv) where candidates used the mass 3.55 g to find the molar mass of XCO_3 or in (v) where, having calculated the molar mass correctly, they used 44 instead of 60 as the mass of the CO_3 component. Errors of this type were penalised only once and many candidates then went on to score well in (c). Most candidates who had made silly slips in (b)(i) stopped after (b)(iii) as they realised they must have made a mistake as a negative relative atomic mass or a very low one seemed unlikely. It was not clear why so few of these candidates did not go back and check where their error was.

Part (c) proved to be a very good discriminator. Many candidates achieved full marks on the section. The main source of error was the calculation of the error in the molar mass based on the percentage error given. Some candidates could not calculate 0.91 % of the molar mass. Almost all combinations of the numbers 0.91,

100 and 115 were seen. Some calculated the answer to 7 significant figures and carried this through the rest of the calculation. This was not penalised. There was more than one way to carry out the calculation and the alternative route based on the mass used and recalculation of the range of molar mass was seen and credited. The main error amongst those who were able to answer (i) - (iii) was in the choice of the possible elements. Those who made errors in (b) were marked consequentially provided the elements listed contained all those in the range and were not non-metals.

In (iv) the common error was to quote the metals as Cs and Ba confusing atomic number with relative atomic mass. The answer Xe was seen, again this is close to the atomic number rather than the mass. Some candidates chose to quote only one metal thus ignoring the question which asks for possible identities, plural. Another case where candidates who had read the words more carefully might have questioned their own answer as it lead to only one possible metal.

Question 5

Part (a) of this question was well done by the vast majority of candidates. The few wrong answers generally lacked detail. Thus 'double bond' was considered too general when carbon-carbon double bond was required. The expected answer for the inference based on the addition of PCl_5 was -OH or hydroxyl. Errors included hydroxide and alcohol.

Part (b) was not marked consequentially on (a). Almost all candidates were able to produce clear structures for $\text{C}_4\text{H}_8\text{O}$. The main errors seen were the usual suspects: 5 valent and 3 valent carbons, too many or too few hydrogen atoms in the structure, bonds to the H in the OH group, double bonds not shown in the structure, and the same isomer twice. Candidates should be encouraged to draw their structures in ink; pencil does not always scan well.

Question 6

Overall this question tested candidates ability to explain why particular techniques were used in the laboratory and propose extensions and modifications to given information to solve problems. Many candidates scored well on this question but some seemed not to have spent enough time understanding the practical details given in the question or chose to ignore the information when asked to modify that detail to solve the problems posed.

In (a)(i) most candidates correctly suggested that the ethanol would act as a solvent for the halogenoalkanes. Other functions for the ethanol included: to act as a provider of hydroxide ions, to act as the nucleophile and to act as a catalyst. Most candidates scored well in (a)(ii) but a few answers concentrated on the flammability of the ethanol and the usual incorrect answer was to suggest that the water bath would keep the temperature constant. The key word in the question is 'same'. Since the experiment is comparative it does not matter what the actual temperature is only that it is the same for all the mixtures. Some candidates thought 'equal' and 'constant' were synonymous. Almost all candidates knew the reason for carrying out the experiment at $60\text{ }^\circ\text{C}$ but comparatively few answered the question asked! It was not enough to say that 'the rate of the reaction increased', the question includes the words 'rather than at room temperature, and asks for a comparison. Some answers suggested that the reactions would not work at room temperature. This lack of precision was penalised.

Part (b) of the question again illustrated the need for candidates to make sure they understood what was going on in the experiment described. Most candidates scored well on this part of the paper but quite often the expected answer followed a lot of unnecessary introduction. A large minority of answers suggested that the extra test would involve adding nitric acid followed by silver nitrate solution then testing the product with various concentrations of ammonia failing to realise they already had the silver halide precipitates in the tubes. Candidates in general were able to describe the colours of the precipitates and the effect of the addition of ammonia solution.

In the planning exercise in the final part of the question many candidates scored 4 marks or above. Candidates were asked to describe an experiment based on the details in (a) that would allow the effect on the rate of hydrolysis of changing from primary to secondary and tertiary halogenalkanes to be investigated. Candidates were told what to use and what details to include in their answers. Almost the only common error among answers where candidates understood the chemistry and the technique was to not address the issue raised in the last part of the information. This states 'and how you will interpret them'. Many candidates lost this mark because they quoted the answer that the tertiary would be fastest followed by the secondary and finally the primary rather than relating the observations or measurements to the solution of the problem.

Common errors among those following the instructions in the question were to fail to identify by name or formula the actual compounds used; forget to add the silver nitrate solution; use alcohols rather than the bromoalkanes; use chloroalkanes; or carry the experiment out three times once with chloro-, once with bromo- and once with iodo- alkanes.

The question stated that the plan must be 'based on the experiment in (a)'. In wrong answers the use of sodium or potassium hydroxide, bromine water, potassium chromate, phosphorus pentachloride, distillation or reflux was common. Candidates who chose to use these techniques or compounds scored very few marks. A small minority of candidate gave very detailed, correct instructions on how to distinguish between primary secondary and tertiary alcohols which again did not score.

Hints for Revision

- Make sure you use technical language precisely e.g. decomposition and combustion are not the same.
- Make sure you understand the chemistry involved in the tests for functional groups in organic chemistry, and ions and gases in inorganic chemistry.
- Make it clear whether a continuation test is being carried out on the same solution or on a new solution
- Make sure you understand the reason behind set procedures used in volumetric analysis.
- When drawing structures for organic compounds/isomers:
 - check that each carbon atom is 4 valent
 - count the number of hydrogens
 - name the compound - this can help prevent the same isomer being drawn twice
- Always ask yourself the questions
 - 'Have I really understood what the question is asking me to do'
 - 'Does my answer to this calculation make sense'

6244/01

General

This paper allowed candidates to demonstrate the full range of knowledge and skills in the specification, utilising some questions requiring simple recall and others which were significantly challenging. The overall standard of the answers was high with some really excellent answers showing both good understanding and an appreciation of the need to set out material clearly and logically.

There was encouraging evidence of improvement in the use of chemical vocabulary although there remain candidates who use terms with scant regard for their meaning (eg the use of atom, ion and molecule interchangeably). Even good candidates needlessly lost marks by failing to follow clear instructions given in the question (eg to include units and to quote answers to an appropriate number of significant figures), by neglecting the cues offered by the mark allocation and by answering a question different from that posed by the exam. Many candidates still do not appreciate that a reagent is a chemical compound in an appropriate state and not a species (eg dilute 'sulphuric acid' not 'acid' or 'H⁺ ions'). It is a real concern that some candidates at this level can present uncritically answers to numerical problems that are plainly absurd (eg enthalpies of solution (exothermic and endothermic) of the order of several thousand kJ mol⁻¹). A2 candidates should be able to formulate a logical sequence of argument in answer to a question rather than simply writing down everything they can think of that might be relevant. It is important that candidates appreciate that they cannot score full marks if their answer includes errors alongside correct responses.

Question 1

This question proved rather more challenging than expected. There were many correct equations for the reaction of aluminium and chlorine in (a)(i), but some gave the equation for the formation of AlCl₃. For (a)(ii) only the better candidates knew both types of bonding present in Al₂Cl₆; covalent bonding was usual but combined with all other types and van der Waals' forces and there were a few bonds between the aluminium atoms. Most candidates realised that it would be sensible to carry out the hydrolysis of silicon tetrachloride in a fume cupboard but toxic or poisonous were the usual reasons. There are still candidates suggesting the use of goggles as a specific safety precaution. In (c)(ii) only the best responses built up a logical argument and far too many candidates relied on unconnected statements about the chemistry of this system. Weaker answers illustrated the problems of incomplete understanding (eg carbon has no d orbitals) and imprecise use of terminology (eg reference to carbon molecules, carbon ions, chloride ions and hydroxide ions). In (d) many candidates confused the property shown by lead(IV) oxide (oxidising) with a theoretical rationale (the +II oxidation state of lead is more stable than the +IV). While most candidates correctly indicated reaction II as the more likely option in (e), few gained the second mark; many simply repeated their answer using a different form of words.

Question 2

Candidates who had thoroughly learned the organic chemistry covered by the unit were able to score very high marks on this question. In (a) most candidates knew the formula of iodoform and many were able to identify the structural feature that results in its formation, draw the structure of the compound and name it. However, a number of candidates failed to note that the question referred specifically to compound A, a carbonyl with a branched carbon chain; this resulted in references to alcohol features that would give a positive iodoform test and to candidates giving the structure of pentanone.

While most candidates correctly identified the aldehydes as the required series in (b)(i) only the better candidates recognised the red precipitate as copper(I) oxide in (b)(ii). Here, as well as a very wide range of alternative compounds, some candidates suggested species (eg Cu⁺

ions) or gave a list of possibilities. In (c) a reagent suitable to convert the salt into the acid was well known. The observation required in (d)(i) was generally known but a number of candidates needlessly lost marks by giving an inference instead of an observation (eg gas or CO₂ evolved). While most candidates were able to write the basic equation for the reaction between a carboxylic acid and a hydrogencarbonate in (d)(ii) many did not appreciate the need to identify the carboxylic acid unambiguously.

Question 3

This was a high scoring question with many candidates showing a good understanding of the key points of acidity. The calculation of the pH of a strong acid in (a)(i) presented few difficulties. Most candidates knew how to calculate the concentration of hydroxide ions for (a)(ii) although the arithmetic caused some problems; typical errors were using the pH rather than the concentration of hydrogen ions and using $K_w = 1 \times 10^{-14} \text{ mol}^2\text{dm}^{-6}$ in the calculation. In (b)(i) the expression for K_a was well known (common errors being the use of the hydrogen ion rather than the oxonium ion and the inclusion of water concentration) as was its use to determine the value of K_a from the pH and concentration in (b)(ii). The majority of candidates chose to use the simplifying assumption that the equilibrium concentration of acid equals the initial concentration although this is not really justified in this situation. It is expected that candidates at A2 will appreciate that the value of the dissociation constant of a weak acid will be less than 1 mol dm^{-3} and is typically well below this.

Identification of the acid and base species in (c)(i) proved a straightforward task but many candidates failed to link the pairs unambiguously by the use of numbers or connecting lines, assuming that the use of the word 'conjugate' connected a pair. Only the best candidates scored the mark in (c)(ii). Most responses ignored the role of phosphoric(V) acid (clearly required by the question) and simply stated that H₂PO₄⁻ was a weak acid. Almost all candidates correctly identified bromocresol green as the suitable indicator in (d), although the explanation for their choice proved less reliable despite the simplicity of this particular question which offered only one indicator with a pK_{in} in the vertical section of the titration graph. Answers such as pK_{in} was equal to the pH at the equivalence point or the colour change occurred at the equivalence point were quite common.

Question 4

This question produced some excellent responses from candidates who read the requirements of the question carefully and showed the necessary precision in their own use of terminology. While there were many concise and accurate definitions of the enthalpy of hydration in (a)(i), it was quite common to see references to atoms, molecules, compounds and substances rather than gaseous ions. It was not always appreciated that the process required infinite dilution and some candidates confused this concept with the use of an infinite amount of water. For (a)(ii) the majority of candidates were aware that hydration involved bond formation but very few went on to identify the processes involved. Some candidates simply stated that the process is exothermic because energy is given out while a small but significant number stated that breaking bonds is an exothermic process.

In (b) the importance of ion radius and of ion charge were well known, although the use of charge density without precise definition remains common. Despite the very specific nature of the question a number of candidates chose to compare the hydroxides in terms of group trends, rather than by considering the effect of size and charge on the attraction between the anion and the cation.

Part (c)(i) produced some notably clear and accurately labelled cycles where candidates appreciated the need for states to be included in all thermochemical systems and understood that the directions of arrows in thermochemical cycles is significant. The calculation on (c)(ii) proved within the capabilities of most candidates and some benefited by using the formula $\Delta H_{\text{solution}} = \Delta H_{\text{hydration}} - \text{Lattice Enthalpy}$ rather than their cycle. However, it was quite common

to see the positive sign omitted despite the instruction in the stem of the question and, where the calculation produced extremely large values, candidates recorded these without evident concern.

In (d) many candidates ignored the instruction to use the data provided and based their comparison on their knowledge of Group II trends thereby greatly adding to the complexity of their answers. Those that did use the data found the question straightforward and, in most cases, scored full marks.

Question 5

This question proved accessible to candidates who knew the essentials of the organic chemistry and who could use their technical vocabulary precisely. In (a) most candidates were able to identify the chiral centre of the molecule and explain the meaning of the term although a common error was to assume that having four different groups attached to a carbon atom invariably confers chirality. Many answers to (b) suggested that a number of candidates were relying on rote learning rather than a clear understanding of the effect of optical isomers on plane polarised light.

Most candidates identified PCl_5 as an appropriate reagent in (c)(i) but far fewer knew a reagent to convert an amide into a nitrile, NH_3 and HCN being common suggestions. The conversion of the acid chloride to an amide was usually recognised as a substitution but the term 'nucleophilic' was often omitted and sometimes replaced by 'electrophilic'. Candidates preferred the Hofmann degradation reaction in (d) and most knew the reagents, aqueous bromine being a common error. The alternative reduction was also well known but very few candidates who chose LiAlH_4 as the reagent appreciated the need for aqueous acid to generate the final product. Working out the structure of the ester formed from Ibuprofen required for (e)(i) proved well within the capabilities of most candidates and the advantages of using the acid chloride ((e)(ii)) were widely understood with only a small minority of candidates suggesting vague benefits centring on the cost of starting materials or the usefulness of the products. Most candidates were aware that the conversion back to Ibuprofen required hydrolysis but marks were quite frequently lost through candidates confusing reagent (eg dilute sulphuric acid) and species (H^+ ion) and it was not always appreciated that an aqueous acid is essential. Where alkaline hydrolysis was used omission of the final acidification was a common reason for losing a mark.

Question 6

Almost all candidates were able to write the correct expression for K_c in (a), failure to use square brackets being the most common error. Many candidates were able to successfully work their way through the steps of the calculation in (b), those who clearly structured their answer being the most likely to score full marks. Recurrent errors were using the number of moles of hydrogen sulphide at equilibrium as the start amount, taking the amount of sulphur as equal to the amount of hydrogen and failing to convert the amounts into concentrations. Some candidates confused K_c with K_p and calculated mole fractions. Failure to express the final answer to two significant figures was surprisingly common. For (c) while almost all candidates were able to predict the effect of increasing pressure on the position of the equilibrium, very few attempted an explanation in terms of the K_c expression and many that did concluded that K_c changed. It is expected that candidates at A2 will be able to analyse the effect of a change in pressure or concentration of an equilibrium in terms of the consequent impact on the expression quotient and the shift in equilibrium to restore equality of the quotient and K . Most candidates were familiar with the effect of a catalyst on the value of K_c and those that noted the reaction was endothermic usually knew the effect of temperature.

Hints for Revision

- Have a clear understanding of the different types of particles involved in chemical systems (atoms, ions and molecules).
- Remember that reagents are the chemicals that are used in the laboratory; specify them by name and the state (gas, liquid, solid or solution) that they must be used. If reagents are used in solution you should indicate the solvent.
- Try to develop an idea of 'reasonable' values for some of the common quantities covered in the specification (eg K_a of a weak acid, typical bond enthalpies and enthalpy changes for reactions).
- Remember that in thermochemistry it is essential to give the states of the species involved.
- Make sure that you understand significant figures.

6245/01

General

This paper seemed to be accessible to the full range of candidates. There was no evidence of any time pressure, with the vast majority of candidates attempting every question. The paper contained some relatively straightforward questions, along with a number of more challenging ones. Some excellent answers were seen by the team of examiners. Answers to calculation questions, in particular, were often laid out clearly and logically. Unfortunately, however, a significant number of candidates had problems in expressing themselves clearly and in longer answers there was a tendency to repeat and/or contradict earlier statements.

Question 1

Part (a)(i) provided a good start for many candidates. In (a)(ii), however, many candidates did not correctly recall the structural formula of the compound formed in the reaction between propenal and 2,4-dinitrophenylhydrazine. In (b), all three marks were frequently awarded. In many cases where full credit had not been given, candidates had either confused nuclear magnetic resonance with other forms of spectroscopy, such as infra-red or mass spectroscopy, or not included the relative areas under the three peaks.

In (c)(i) and (d)(i), many good mechanisms were seen although a lack of precision was noticeable if structural formulae were drawn too small. Inaccuracy in the position of the head and the tail of each curly arrow was more likely to occur in such cases. Many candidates remain under the impression that a curly arrow represents the movement of an atom or group of atoms to form a new linkage. A minor slip, such as the omission of the negative charges on the cyanide and bromide ions, occasionally spoilt some otherwise correct answers.

In (e), many candidates earned two out of the three marks available. The fact that the carbon to carbon double bond is a region of high electron density, or words to that effect, was not mentioned by a significant majority of candidates. The Quality of Written Communication affected many answers, with imprecise use of chemical terminology prevalent on many occasions.

Question 2

In (a), the electronic configurations of the nickel atom and ion often gained full credit. In (b), the reason for many incorrect definitions was that candidates omitted the word "ion", thereby implying that the atoms had to have partially filled d-subshells. In (c)(ii), the formula of the nickel(II) hydroxide precipitate alone was frequently given instead of a balanced equation as required by the question. Candidates' explanation of deprotonation in (c)(iii) often failed to include the fact that the hydrogen ion was lost from a ligand water molecule, whilst lack of precision in the language used suggested that hydrogen atoms (rather than ions) were removed from the complex ion. A significant number of candidates could not balance the ligand exchange equation in (c)(v), despite stating a correct formula for the nickel-containing complex ion formed in excess ammonia solution. Some excellent answers were seen in (d) to explain the origin of the colour in the hexaaquanickel(II) ion. There were candidates, however, who either referred

erroneously to the emission of light as electrons fell back down again after promotion or stated that the splitting of the d-orbitals occurred as a result of the incident light rather than the ligands.

Question 3

Part (a) required precise definitions for two terms, namely rate of reaction and overall order of reaction. The definitions for rate of reaction often did not include any mention of change in concentration of a reactant or product. Instead, candidates related rate to the speed of the reaction or the time taken to reach the end of the reaction. Answers which correctly defined the overall order of reaction often included a general rate equation to illustrate the concept. In (b)(i), the majority of candidates could deduce the two orders of reaction, but not all of them justified their answers with sufficient rigour. It is important for candidates to realise and state that while doubling the concentration of one reactant, the other must remain constant. In (b)(iii), the value of the rate constant was usually correct, but a significant number of candidates either omitted the units or failed to notice that the initial rate of reaction had been measured in units of $\text{mol dm}^{-3} \text{min}^{-1}$ rather than $\text{mol dm}^{-3} \text{s}^{-1}$. Part (b)(iv) proved to be highly discriminating. For those candidates who were able to relate the kinetics of the reaction to its mechanism, full marks were scored. A significant majority were wrong-footed and simply quoted “S_N1” or “S_N2” as mechanisms, whilst others attempted to recall a specific reaction mechanism. In (c), a surprising number of candidates were unable to plot the four points accurately. Those who were able to do so often went on to calculate a correct numerical value for the gradient, but then omitted the negative sign. The corresponding value for the activation energy was marked consequentially on the answer for the gradient. There was, however, confusion as to whether to use J or kJ in the final answer and otherwise correct answers frequently omitted mol^{-1} .

Question 4

In (a)(i), many candidates did not describe the appearance of the organic product, but referred instead to the decolourisation of the aqueous solution of bromine. In (a)(ii), the formation of 2,4,6-tribromophenol was known by many candidates, but the omission of hydrogen bromide as a co-product prevented access to the second mark available for a fully balanced equation. The ester product was frequently drawn correctly in (a)(iii), but some candidates did not show the presence of a C=O bond in the structural formula. Part (a)(iv) proved to be highly demanding. The effect of the electronegative chlorine atom on the carbon atom to which it is bonded in ethanoyl chloride was frequently overlooked.

Those who had learnt accurately the reagents and conditions necessary for organic reactions scored well on (b) and (c)(i). In both (b) and (c)(i), some candidates needed to indicate that the “HCl” written was hydrochloric acid and they should not have assumed that this was so. In (c)(ii), candidates often failed to state why temperatures of less than 0°C were unsuitable. The structural formula of the dye was often drawn correctly in (c)(iii) and the process of recrystallisation was, in many scripts, described succinctly in (c)(iv). Unfortunately, in (c)(iv), some candidates appeared to be totally unfamiliar with the process of recrystallisation, thereby perhaps exhibiting a lack of practical experience at the laboratory bench.

Question 5

Part (a)(i) was often not clearly answered. Many candidates correctly calculated the emf for the reaction between potassium manganate(VII) and dilute hydrochloric acid under standard conditions as +0.15V, but then went on to say that this reaction was not feasible as the emf value was below +0.3V. It was evident from many responses to (a)(ii) that a sizeable proportion of candidates are under the mistaken impression that the pale pink colour observed at the end-point of a titration involving potassium manganate(VII) is due to the presence of manganese(II) ions rather than the first excess of potassium manganate(VII). Part (b)(i) was, in general, answered correctly and many excellent answers to the calculation in (b)(ii) were seen. Candidates who ran into difficulties often started with the assumption that the tablets were pure hydrated iron(II) sulphate, despite a clear indication to the contrary in the stem of the question. Some candidates did not scale up the number of moles of iron(II) ions in a 25.0 cm³ portion to the amount present in the original 200 cm³ of solution in the volumetric flask. Part (c)(i) was often correctly answered, but the departure from standard conditions was frequently left unembellished in (c)(ii).

Hints for Revision

- Always draw 'curly arrows' in mechanisms precisely by carefully considering where the head and tail of each arrow is located
- Practise constructing fully balanced equations making sure that you do not omit any of the products
- Make sure that you learn definitions, such as those for rate of reaction and overall order of reaction, word-perfectly
- Ensure you are familiar with organic practical techniques such as recrystallisation
- Learn all reagents and conditions for the organic reactions included in the Specification

6246/01 (Internal Assessment of Practical Coursework)

General

This report should be read with the preceding 6243/01 one since all of the points relating to the administration of the scheme apply equally here and are not repeated.

As with the AS scheme most centres use exclusively the Edexcel exercises from the Internal Assessment of Practical Coursework Issue 2 (August 2003) booklet. Centre assessors should be aware that exercises taken from previous editions are no longer valid and are likely to be discounted by the moderator. Centre-designed exercises are welcomed by the moderators providing they have been approved in advance. In particular the mark schemes must be in the same format to those in Issue 2. Centre-designed exercises must have;

- Candidate instructions to match those in the Edexcel exercises.
- A 15 mark total which may be scaled down from a higher working total.
- Each mark accountable with a brief description of the criteria for its award.
- A range of criteria in-line with the Edexcel exercises for similar procedures. eg a titration should award 1 mark for concordant titres and up to 4 marks for accuracy.

Now that the revised scheme has been successfully operating for three sessions it may be of interest to note popular combinations of exercises used. These assume that the minimum four assessments only are carried out. These are all taken from samples submitted to the moderators in 2006.

Centre	Ability			
	A	B	C	D
1	A2.1	A2.9	A2.4, A2.10	A2.4, A2.10
2	A2.3	A2.15	A2.5, A2.11	A2.5, A2.11, A2.15,
3	A2.14	A2.7	A2.10, A2.13	A2.10, A2.13

Organisation of samples

A number of centre assessors still fail to organise the sample of work for their moderator in a satisfactory way. A sample of work should meet the following criteria.

- Include only the work of the candidates asterisked on the OPTEMS and, if not already covered by these, the work of the highest and lowest scoring candidate.
- Include only the exercises for which the marks have been included in a candidate's mark profile.
- Have each candidate's exercises collected together with a record sheet as the cover.
- Have the marks used in the total on 75 circled on the record sheet.
- Be accompanied by tick grids, supervisor values and evidence that centre designed exercises have been approved by the Principal Moderator.

Comments on assessment of the abilities

Ability A Planning

A popular planning exercise is A2.3 Planning an investigation to identify a carbonyl compound. When marking this exercise assessors should not award marks 12-16 unless actual values are given for a chosen compound. For example if propanone is chosen then the m/e value from the mass spectrum should be given as 58 and the wavenumber range of the C=O peak in the IR spectrum quoted from a data book or the Edexcel User Guide.

Ability B Manipulation

It is worth emphasising the point made in the 6243/01 report that the moderator must be given the information used by the assessor to assess accuracy where this is included in the ability B mark scheme. The moderator finds it most useful when the expected value is written alongside the candidate's actual value and the difference between the two shown. Both of the redox titration exercises, A2.8 and A2.9, are popular with centres and are recommended. They both give consistent titres if properly carried out. Candidates with good manipulative skills should be able to gain high marks.

Ability C Observing and recording

In test 6 of Exercise 2.13 it is unlikely that candidates will record a brown precipitate as an observation when concentrated hydrochloric acid is added to aqueous potassium manganate(VII). The mark scheme may be modified to; Purple solution (1), Any brown (1), Litmus bleached (1). This correction was included in the Summer 2004 Examiners' Report.

As with the AS scheme there are some assessors who award observation marks too generously. Unless a candidate's observation matches that in the mark scheme it should not receive a mark. An exception to this is test 3(a) in Exercise A2.11 in which aqueous sodium hydroxide is added to cobalt chloride solution. The initial precipitate is blue and should slowly turn pink or red so the mark scheme may be modified accordingly.

Ability D Interpretation and evaluation of experimental results

The 2004 Examiners' Report for 6246/01 explained that, in Exercise A2.5, the mass spectrum on page 32 is for propanone and not, as was intended, for propanal. The wording of the instructions and the mark scheme may be modified if assessors so wish. If, of course, candidates use the spectrum simply to find the m/e value of the molecular ion, and therefore the molecular mass of S then no change need be made.

Risk assessments

The Edexcel exercises do not include health and safety information for either candidates or technicians. It is expected that assessors will carry out risk assessments when preparing assessment exercises for their candidates. If they consider that the risk when using a particular reagent or a procedure is unacceptable then they may make changes to the exercise to minimise the risk. An example of this may be to use solutions of lower than the suggested concentration in observation exercises. One moderator has suggested that 0.5 mol dm^{-3} sodium hydroxide solution may be substituted for 1.0 mol dm^{-3} in some exercises. If assessors choose to do this then they should try out the tests in advance of their candidates. Assessors are welcome to consult the Principal Moderator via the Assessment Leader if they wish to raise safety issues. Appendix B on page 95 of Issue 2 of the Edexcel Internal Assessment of Practical Coursework gives useful information on safety.

Summary

Assessors must take careful note of any comments on their E9 for 2006 and make changes to their implementation of the scheme for 2007 if required to do so.

The moderators thank centre assessors, technicians and candidates for making the assessment scheme run so smoothly for another year.

Hints for carrying out coursework

- When you are adding one aqueous solution to another mix the solutions by shaking the test tube gently from side-to-side. Layers will never be formed when two aqueous solutions are mixed.
- The test for the sulphate ion in solution is to add barium chloride solution and dilute hydrochloric acid. The hydrochloric acid is added to destroy any anion other than sulphate that may also form a white precipitate with barium chloride.
- When you are asked to suggest improvements to an experiment there is no point in simply repeating it. Rather you should suggest modifications to the method such as timing exactly when solutions are mixed in a rates investigation.
- Read burette volumes to the nearest 0.05 cm^3 . Average consistent titres and record the average to the second decimal place or to the nearest 0.05 cm^3 .

6246/01A (Practical Test)

General

The tests all worked as expected. The tests are checked in the weeks before the examination by the Principal Examiner using the materials supplied and other reagents exactly as specified in the Instructions. Although it is not actually demanded by the awarding body it is recommended that supervisors try the tests in their own laboratory before the day of the examination.

Supervisors should note that the Instructions and copies of the question papers are issued to centres under the strictest confidence. The Candidate Information included with the Instructions is the only information that may be divulged to candidates. There must be no attempt to assist candidates by passing on more information, even in a general form, concerning the exercises.

Question 1

Compound A was hydrated iron(II) sulphate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

Compound B was potassium chloride, KCl .

In (a) it was not expected that candidates would attempt to identify A as an iron(II) compound from its colour alone but some attempted to do so. The change in colour of the hydroxide precipitate in (b) from green to brown was enough to confirm that the cation in A was iron(II) and not nickel(II) or chromium(III) as some candidates suggested. The only acceptable observation in the positive barium chloride test in (c) was the formation of a white precipitate. When dilute hydrochloric acid was added after the barium chloride then the observation should have been that the precipitate is insoluble in the acid inferring that A was a sulphate.

It was expected that the silver halide precipitate formed in (e) would be obviously white and that it would readily dissolve in dilute ammonia so that chloride could be inferred as the anion in B. The most accurate inference following a lilac flame in (f) was “potassium ion” rather than just “potassium”.

Question 2

Compound C was propanal.

Compound D was butan-1-ol.

The tests in (a) to (e) generally gave the expected observations with the possible exception of Fehling's test in (b). If the test failed to give a red precipitate then the inference of a ketone was given credit as was the structure of propanone in (c). It was intended that candidates followed the advice in the stems of (d) and (e) but many failed to do so. The formation of an ester in (d) should have suggested that D was an alcohol. The further information as a result of the test in (e) should have allowed candidates to infer that D was either a primary or secondary alcohol.

After drawing correct structures for two possible isomers in (f)(i) some candidates failed to give the expected iodoform reagents in (ii). Rather they chose to oxidise the isomers with acidified potassium dichromate(VI) then to immediately add Tollen's or Fehling's solution to the reaction mixture. Although this answer was not the intended one the observations in (iii) did, at least, receive credit.

Question 3

Compound E was ethyl ethanoate.

This exercise had been set in the 2003 paper so candidates may well have practised the procedure. It is quite difficult to judge when the bubbles begin and stop escaping so it was encouraging to see many accurate temperatures recorded in Table 1. The identity of the ester was marked consequentially on the mean of the two temperatures recorded in Table 1. Part (c) was not identical to the equivalent question in 2003 but some candidates seemed to be writing an answer to the older question. Candidates need to be made aware of the fact that although questions may be similar to those previously asked they are unlikely to be identical. An answer that was appropriate to such a previous question may well not receive full credit on the second occasion.

Question 4

This question proved to be straightforward for almost all candidates in many centres. Many scored the maximum seven marks. The solubility table was included in (a) to make the question more accessible but, possibly, was not needed by many candidates and, indeed, made the question too easy for others. Candidates should be made aware that they must not assume the identity of unknowns then simply confirm them. When expected observations are required the colour of the precipitate should be included. As ever it is vital to read the full question. In this case excess ammonia solution was needed to distinguish between the solutions of the chlorides of aluminium and zinc.

Similarly in (b) the addition of excess ammonia was needed to dissolve the initial precipitate of zinc hydroxide. Filtration then removed the precipitate of aluminium hydroxide.

Hints for Revision

- When a precipitate does not dissolve in excess reagent, record this as “the precipitate is insoluble in excess” rather than just that “the precipitate is insoluble”.
- The expected observation when an aldehyde reacts with Fehling’s solution is a red precipitate.
- If a silver halide precipitate dissolves in a small volume of dilute ammonia it will be silver chloride. Silver bromide will only dissolve in a large volume of dilute ammonia or in a small volume of concentrated ammonia.
- Do not be tempted to suggest the identity of some d-block metal ions from the colour of their compounds alone. A green solid may be a compound of iron(II), nickel(II) or chromium(III). Further tests are needed to confirm the identity of the metal ion.

6246/01B (Practical Test)

General

The tests all worked as expected. The tests are checked in the weeks before the examination by the Principal Examiner using the materials supplied and other reagents exactly as specified in the Instructions. Although it is not actually demanded by the awarding body it is recommended that supervisors try the tests in their own laboratory before the day of the examination.

Supervisors should note that the Instructions and copies of the question papers are issued to centres under the strictest confidence. The Candidate Information included with the Instructions is the only information that may be divulged to candidates. There must be no attempt to assist candidates by passing on more information, even in a general form, concerning the exercises.

Question 1

Compound F was hydrated cobalt(II) sulphate, $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$.

Compound G was sodium iodide, NaI .

Since the only red or pink compounds that candidates are expected to recognise are those of cobalt(II) the expected inference in (a) was that the cation in F was, indeed, cobalt(II). Although missed by many candidates the blue precipitate initially formed in (b) did turn pink after a short time. The only acceptable observation in the barium chloride test in (c) was the formation of a white precipitate. Candidates should have allowed for the fact that this is formed in a red solution. When dilute hydrochloric acid was added after the barium chloride then the observation should have been that the precipitate is insoluble in the acid inferring that F was a sulphate.

It was expected that the silver iodide precipitate formed in (e) would be obviously yellow and that the oxidation of the iodide ions by hydrogen peroxide in (f) would be recognised by candidates as forming iodine. The most accurate inference following a yellow flame in (g) was "sodium ion" rather than just "sodium".

Question 2

Compound H was propanal.

Compound J was propan-1-ol.

The tests in (a) to (e) generally gave the expected observations with the possible exception of the silver mirror test in (b). If the test failed to give a silver mirror or black precipitate then the inference of a ketone was given credit as was the structure of propanone in (c). It was intended that candidates followed the advice in the stems of (d) and (e) but many failed to do so. The formation of an ester in (d) should have suggested that H was an alcohol. The further information as a result of the test in (e) should have allowed candidates to infer that J was either a primary or secondary alcohol.

After drawing correct structures for two possible isomers in (f)(i) some candidates failed to give the expected iodoform reagents in (ii). Rather they chose to oxidise the isomers with acidified potassium dichromate(VI) then to immediately add Tollen's or Fehling's solution to the reaction mixture. Although this answer was not the intended one, the observations in (iii) did receive credit.

Question 3

Compound K was methyl propanoate.

This exercise had been set in the 2003 paper so candidates may well have practised the procedure. It is quite difficult to judge when the bubbles begin and stop escaping so it was encouraging to see many accurate temperatures recorded in Table 1. The identity of the ester was marked consequentially on the mean of the two temperatures recorded in Table 1. Part (c) was not identical to the equivalent question in 2003 but some candidates seemed to be writing an answer to the older question. Candidates need to be made aware of the fact that although questions may be similar to those previously asked they are unlikely to be identical. An answer that was appropriate to such a previous question may well not receive full credit on the second occasion.

Question 4

This question proved to be straightforward for almost all candidates in many centres. Many scored the maximum seven marks. The solubility table was included in (a) to make the question more accessible but, possibly, was not needed by many candidates and, indeed, made the question too easy for others. Candidates should be made aware that they should not assume the identity of unknowns then simply confirm them. When expected observations are required the colour of the precipitate should be included. If ammonia was added to the solutions of silver nitrate and lead nitrate then the different colours of the precipitates could be used to distinguish between the two solutions. If ammonia was added to dissolve silver and lead chloride precipitates then the ammonia solution should have been in excess. In (b) the addition of excess ammonia was needed to dissolve the initial precipitates. Filtration then removed the precipitate of lead(II) hydroxide allowing a solution containing the silver complex ion to be collected as a filtrate.

Hints for Revision

- When you are instructed to add a reagent until no further change is seen a precipitate often forms at first. You should then continue to add reagent to find out whether the precipitate dissolves in excess
- When a precipitate does not dissolve in excess reagent, record this as “the precipitate is insoluble in excess” rather than just that “the precipitate is insoluble”.
- If the addition of hydrogen peroxide to a suspected iodide solution forms a brown solution then the iodide ions have been oxidised to iodine.
- If a precipitate forms when both barium chloride solution and dilute hydrochloric are added to a solution the precipitate must be barium sulphate. Describe this as a white precipitate even if it forms in a coloured solution.

6246/01C (Practical Test)

General

The tests all worked as expected. Some centres were unable to obtain supplies of propanal for Q2 so, on request to the Assessment Leader, were allowed to substitute ethanal. Similarly in Q3 some centres had to substitute a different liquid for the specified ethyl ethanoate. When changes are made to the specified materials in the practical test it is vital that this information is passed on to the examiner by means of the Questionnaire. Supervisors should note that the Instructions and copies of the question papers are issued to centres under the strictest confidence. The Candidate Information included with the Instructions is the only information that may be divulged to candidates. There must be no attempt to assist candidates by passing on more information, even in a general form, concerning the exercises.

Question 1

Compound P was hydrated nickel(II) sulphate, $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$.

Compound Q was potassium iodide, KI.

In (a) it was not expected that candidates would attempt to identify P as a nickel(II) compound from its colour alone but some attempted to do so. The fact that the hydroxide precipitate in (b) did not dissolve in excess sodium hydroxide nor turn brown was enough to confirm that the cation in P was nickel(II) and not chromium(III) as some candidates suggested. The only acceptable observation in the positive barium chloride test in (c) was the formation of a white precipitate. Candidates should have allowed for the fact that this is formed in a green solution. When dilute hydrochloric acid was added after the barium chloride then the observation should have been that the precipitate is insoluble in the acid inferring that P was a sulphate.

It was expected that the silver iodide precipitate formed in (e) would be obviously yellow and that the oxidation of the iodide ions by hydrogen peroxide in (f) would be recognised by candidates as forming iodine. The most accurate inference following a lilac flame in (g) was “potassium ion” rather than just “potassium”.

Question 2

Compound R was propanal.

Compound S was ethanol.

The tests in (a) to (e) generally gave the expected observations with the possible exception of Fehling’s test in (b). If the test failed to give a red precipitate then the inference of a ketone was given credit as was the structure of propanone in (c). Some candidates gave the m/e value of a fragment rather than of the molecular ion in (c). It was intended that candidates followed the advice in the stems of (d) and (e) but many failed to do so. The formation of an ester in (d) should have suggested that S was an alcohol. The further information as a result of the test in (e) should have allowed candidates to infer that S was either ethanol or a methyl secondary alcohol. It was incorrect to infer that S was a methyl ketone since it was already known to be an alcohol. After drawing a correct structure for ethanol in (f)(i) few candidates gave a full explanation worth both marks in (ii). All that was required was to explain that the three peaks in the spectrum are due to protons in three different environments and that the relative areas match the number of each different type of proton. Although the expected reagent in (iii) was phosphorus pentachloride others were accepted including acidified potassium dichromate(VI).

Question 3

Compound X was ethyl ethanoate.

This exercise had been set in the 2003 paper so candidates may well have practised the procedure. It is quite difficult to judge when the bubbles begin and stop escaping so it was encouraging to see many accurate temperatures recorded in Table 1. The identity of the ester was marked consequentially on the mean of the two temperatures recorded in Table 1. Part (c) was not identical to the equivalent question in 2003 but some candidates seemed to be writing an answer to the older question. Candidates need to be made aware of the fact that although questions may be similar to those previously asked they are unlikely to be identical. An answer that was appropriate to such a previous question may well not receive full credit on the second occasion.

Question 4

This question proved to be straightforward for candidates in some centres. Many scored the maximum seven marks. The solubility table was included to make the question more accessible but, possibly, confused some candidates. Some described testing the precipitates for solubility by adding water. It was essential to realise that barium carbonate is insoluble. The addition of aqueous barium chloride solution to the four solutions would cause three white precipitates to be formed yet very many plans stated that only the two sulphates would give a precipitate. Another common error was to assume the identity of the solutions then to test to confirm their identity. When expected observations are required the colour of the precipitate should be included. There were some very complex plans that involved mixing all possible combinations of the four solutions and ignoring the aqueous barium chloride. As ever candidates must be told to read the whole question carefully before writing their answer.

Hints for Revision

- When you are instructed to add a reagent until no further change is seen a precipitate often forms at first. You should then continue to add reagent to find out whether the precipitate dissolves in excess.
- When a precipitate does not dissolve in excess reagent, record this as “the precipitate is insoluble in excess” rather than just that “the precipitate is insoluble”.
- When you write an inference make sure that you consider all the previous ones. If a compound is already known to be an alcohol then the inference for an iodoform test should not include methyl ketone.
- Do not be tempted to suggest the identity of some d-block metal ions from the colour of their compounds alone. A green solid may be a compound of iron(II), nickel(II) or chromium(III). Further tests are needed to confirm the identity of the metal ion.
- There are insoluble barium salts other than barium sulphate. Barium carbonate forms as a white precipitate when aqueous barium chloride is added to a solution of a carbonate. If hydrochloric acid is added before the barium chloride then the precipitate does not form since the hydrochloric acid destroys the carbonate ion.

6246/02

This was a synoptic paper as the questions covered a range of topics from AS and A2 chemistry. There were a number of straightforward parts to the questions that most candidates should have been able to attempt but there were also some more challenging questions that the candidates had to think more carefully about and apply their knowledge and understanding.

Question 1

Some candidates did not read all of the information given about the analysis of aspirin tablets and assumed the colour change of phenolphthalein would be colourless to pink as in other titrations they have performed. Some candidates suggested magenta and other red or purple initial colours, without realising that these would have changed to pink near the end point. Many candidates realised that methyl orange changes colour at low pH values so the salts must have a slightly alkaline pH, although values of 12-14 were given by some candidates.

The calculations in (b)(i) and (ii) were done extremely well by a large number of candidates, with most of them working logically through the steps and explaining all of their working. Weaker candidates just wrote a lot of numbers and muddled their way through. Some common errors were omitting the factor of 10 when comparing the number of moles in 25 cm³ and 250 cm³, assuming the aspirin was 100% pure and working out the number of moles of it, then the amount of sodium hydroxide that would have reacted and assuming that NaOH and HCl react in a 1:2 or 2:1 ratio. Some candidates obtained a mass greater than the starting mass of 1.5 g so they just turned their percentage calculation upside down to obtain a reasonable value! Where possible, consequential marks were awarded following one incorrect step, although this was sometimes difficult for the candidates who did not explain their working.

The majority of candidates recognised and could draw the carboxylic acid functional group, although some split it into a carbonyl and an alcohol, but a surprisingly large number did not recognise the ester and only identified the C=O as a carbonyl or a ketone.

Question 2

There were many excellent answers to the identification problem in (a) that were a pleasure to mark. Some good candidates who could identify D, E, F and G did not score full marks as they did not use all of the information given in the question. Some weaker candidates were not able to calculate the empirical formula as they rounded 2.5 to 2 or 3 and even those that had the correct answer often missed out steps in the calculation, such as dividing the number of moles by the smallest to get the simplest ratio. Some candidates ignored the molar mass and did not deduce the molecular formula. Most candidates recognised the iodoform test and could identify G, but did not state that E had to be a methyl secondary alcohol, many thought any secondary alcohol would give this result. Many realised that E would have to be propan-2-ol, but then they suggested D as the ester from propan-1-ol. Some candidates thought that F was ethanoic acid as they ignored the sodium hydroxide that would make it into sodium ethanoate. Many candidates did not state how they knew that F contained two carbon atoms. Candidates should be reminded to check what they write as there were many contradictory names and

formulae given. If they change their mind about an answer they should cross out the incorrect answer. Some candidates failed to give the equation for the hydrolysis of D but did attempt to give the much more difficult iodoform equation.

The synthesis in (b) was well-answered by many candidates, with the formation of methylbenzene as the intermediate being the most common route. The most common error with this route was to omit to add dilute acid at the end to convert the sodium salt into benzoic acid. Some candidates tried to go straight from methyl benzene to benzoic acid by heating with acidified potassium manganate(VII) but this will not work. Candidates should be reminded that if they use potassium manganate as a reagent they should include the oxidation number with the name or give the correct formula to make it clear which one they mean. Some candidates chose to use methanoyl chloride as an acyl chloride, even though this does not exist, but they were given credit for the rest of the synthesis. All other feasible routes were given credit.

The mechanism was often given full marks in (c). The most common errors were not knowing how the NO_2^+ ion is formed, drawing curly arrows starting or finishing at the wrong places, putting too many or no charge on the intermediate ion and an incorrect partial circle.

Question 3

Candidates who had revised the production of nitric acid by the catalytic oxidation of ammonia usually scored high marks for (a). Some candidates did not know the specific conditions needed for this process but they could score 3 marks by justifying the temperature and pressure for the equilibrium reaction. Many candidates confused this process with the Haber Process for making ammonia and it was not unusual to see a temperature of 450°C and a pressure of 250 atmospheres, even though the candidate had previously written that the highest yield is obtained at low pressure. Many candidates wrote about the high pressure increasing the rate of reaction, although the rate is already high at low pressure.

The candidates who realised that the half equation with tartrate ions needed to be reversed usually scored full marks for (b)(i), although a few left H^+ and H_2O on both sides of the equation. Quite a large number of candidates were unable to identify the correct reactants and products. Many candidates did not give the two observations required in (b)(ii) and just wrote that the reaction was faster with a catalyst, without saying how they know this. Many candidates deduced that the cobalt ions had variable oxidation states but quite a large number thought that they were solid and had active sites. The answers to (b)(iii) were often disappointing. The Maxwell-Boltzmann distribution was poorly remembered from AS Chemistry. It was not unusual to see the axes the wrong way round, or incorrectly labelled, for example, with temperature; the curve poorly drawn, frequently leveling off a long way from the x axis, or slightly curved upwards at the end, two curves drawn for different temperatures and some activation energies were far too close to the peak. The explanations were equally disappointing with comparatively few candidates using their graph to show the increase in the number of molecules with energy equal to or greater than the activation energy by labelled shading. Quite a large number of candidates just referred to the total number of molecules under the curve. Only the better candidates explained how this increase in molecules led to an increase in the rate of reaction.

The calculation in (c) was frequently done very well, with many candidates scoring full marks. A few candidates were not familiar with calculations involving gas volumes and some assumed that hydrogen peroxide was a gas, even though they were told that it was a solution.

Question 4

This was slightly more popular than the other two questions in Section B.

Many candidates could write the correct balanced equation for the reaction in (a)(i) but a surprisingly large number could not. There were quite a few equations producing oxygen and all possible oxides of iron were seen. Candidates should read the information given in the stem of the question as all the reactants and products were mentioned or in the table of data. Those that worked out the correct equation usually calculated the enthalpy change correctly, although some forgot to multiply the carbon monoxide and dioxide changes by 3 and others had the sign wrong. A simple answer that the reduction in (i) is exothermic while that in (ii) is endothermic was expected for (a)(ii) but many candidates were muddled and tried to discuss activation energy.

Part (b)(i) was done very well by a large number of candidates, however, (ii) showed a misunderstanding by even many strong candidates. The most common answer was 'the forward reaction is exothermic so an increase in temperature moves the equilibrium position to the left, so the value of K_p decreases'. Candidates should be taught that the value of K_p decreases because the reaction is exothermic and the equilibrium position moving is a consequence of this, not the cause of it.

The rusting of iron was not as well-known as expected. Quite a few candidates knew the half-equation for the reaction at Y, although quite a lot thought that Fe^{3+} was formed immediately, but only the better candidates could work out the equation at X and many different products were seen. The precipitate was often identified as iron(III) oxide, even though it was green.

The structure of Fe_2Cl_6 was drawn correctly by many candidates but there were also a lot of very poor structures drawn. Common errors included an Fe-Fe bond, ionic bonding, metallic bonding, incorrect dative covalent bonds and various intermolecular forces of attraction.

Tests for Fe^{3+} ions were usually well-known and described, although some who had identified the green precipitate in (c) as a compound of iron(III) frequently recorded green precipitate as an observation here as well. The explanation of the acidity of iron(III) chloride was done very well by good candidates, but the weaker candidates did not score here as they just thought that HCl formed. Some candidates who attempted an explanation mentioned deprotonation but did not specify what does the deprotonation and why it occurs. Many candidates did not score a mark as they assumed that protons exist on their own in a solution.

Hints for Revision

- Practise all types of moles calculations and always explain every step of your working.
- Learn all the functional groups in the organic chemistry part of the specification.
- Revise all topics from AS Chemistry for this examination as well as the A2 topics.
- Practise combining half equations to make an overall equation for a reaction.
- When a question asks for observations, write down what you would see, not the inference.
- Revise rusting of iron and the half equations involved.

Appendix A Statistics

6241/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	47	41	35	29	24
Uniform boundary mark	90	72	63	54	45	36

6242/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	46	40	34	28	23
Uniform boundary mark	90	72	63	54	45	36

6243/01 cwk + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	80	72	64	57	50
Uniform boundary mark	120	96	84	72	60	48

6243/01A + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	75	67	59	52	45
Uniform boundary mark	120	96	84	72	60	48

6243/01B + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	74	66	58	51	44
Uniform boundary mark	120	96	84	72	60	48

6243/01C + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	74	66	58	51	44
Uniform boundary mark	120	96	84	72	60	48

6243/01T tcwk+ 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	80	72	64	57	50
Uniform boundary mark	120	96	84	72	60	48

6244/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	56	49	43	37	31
Uniform boundary mark	90	72	63	54	45	36

6245/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	54	47	41	35	29
Uniform boundary mark	90	72	63	54	45	36

6246/01 cwk + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	80	73	66	60	54
Uniform boundary mark	120	96	84	72	60	48

6246/01A + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	77	69	61	53	45
Uniform boundary mark	120	96	84	72	60	48

6246/01B + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	75	66	58	50	42
Uniform boundary mark	120	96	84	72	60	48

6246/01C + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	73	64	56	48	40
Uniform boundary mark	120	96	84	72	60	48

6246/01T tcwk + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	80	73	66	60	54
Uniform boundary mark	120	96	84	72	60	48

Notes

Maximum Mark (Raw): the mark corresponding to the sum total of the marks shown on the mark scheme.

Boundary Mark: the minimum mark required by a candidate to qualify for a given grade.

Appendix C - online marking (ePEN)

Most of the chemistry papers are now marked online by ePEN (electronic Performance Evaluation Network). ePEN allows the user to mark sections of papers, known as items. Scripts are scanned into the system and divided (electronically) into individual responses which correspond to each item. The following is offered as a guide to teachers preparing candidates for the exam.

1. Candidates should write their answers in the spaces provided on the question paper. They should be reminded that the mark allocation is more likely to be the best guide as to how much to write, not the number of lines or the space provided. If a candidate has more to write than the space allows s/he can:
 - extend the answer beyond the borders or
 - use space on a “blank page” or
 - use space after other questions

The candidate must alert the examiner to the fact that there is more of an answer written elsewhere on the script by writing, for example, “see page #” or “see below” or by using an arrow to point to the rest of the answer. This will enable the examiner to refer the matter to the Team Leader who can see the whole script.

It is the candidate’s responsibility to clearly indicate next to their answer that there is more written elsewhere on the script and where it can be found.

N.B. An additional answer sheet (or booklet) is only necessary where there is a significant amount of additional writing needed.

2. As per normal candidates must write their answers in dark blue or black ink. Pencil is permitted for graphs and diagrams (and is visible when the script is scanned). Candidates are not permitted to use other coloured inks (red is still frequently seen). Some coloured inks do not scan very well and are not very visible.

Candidates should also be informed that they are wasting their time using coloured inks to highlight different features on their answer - the script is scanned in monochrome and hence any differentiation is lost.

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481

Email publications@linneydirect.com

Order Code UA017774 Summer 2006

For more information on Edexcel qualifications, please visit www.edexcel.org.uk/qualifications
Alternatively, you can contact Customer Services at www.edexcel.org.uk/ask or on 0870 240 9800

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH

edexcel 
advancing learning, changing lives

A PEARSON COMPANY

