

Examiners' Report Summer 2007

GCE

GCE Chemistry Nuffield (8086/9086)

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Summer 2007

Publications Code UA019008

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6251/01

General

Examiners were generally quite pleased with the quality of answers seen, particularly in the calculations and questions testing factual recall. They were less impressed with answers involving descriptions and explanations, both with regard to the quality of English and to the appropriate use of technical vocabulary. The terms "atom", "molecule" and "ion" were frequently confused.

Section A

Q1 was handled well by the majority of candidates. Most balanced the thermal decomposition equation successfully and knew the colour given by pH indicator paper when in contact with a solution of the product. However, a significant minority gave Ca^{2+} or O^{2-} as the ion responsible for this colour change, and even H^+ was occasionally quoted as the ion responsible for the blue colour of the indicator.

Q2 was generally answered well; the commonest mistake was to provide an extra shell of electrons for the oxide ion. Covalent structures were sometimes drawn, and this was surprising in view of the fact that the question steered candidates towards ionic bonding.

Candidates coped well with Q3 and there were several excellent explanations in support of the claim that the hydride ion is the larger ion.

Most gave an appropriate colour for the strontium flame test in Q4, and there was usually a good understanding shown of the electronic processes occurring during ionisation and excitation. Even so, a few candidates became so carried away with a full description of the excitation process that they failed to mention or describe ionisation altogether, and therefore were unable to gain the mark available.

In Q5 the vast majority knew how to calculate the concentration of the solution of ethanoic acid, but a few multiplied the number of moles by $(\frac{25.0}{1000})$ instead of by $(\frac{1000}{25.0})$.

Question 6

This question was the best answered question in section B, and most candidates were able to define the term "isomers" successfully. Perhaps inevitably, many defined "isotopes" instead, and a few used the expression "chemical formula" or "empirical formula" as opposed to "molecular formula". In (b)(iii) the reagents needed for the oxidation of butan-1-ol were widely known, but a few spoil their answers by giving an incorrect oxidation number such as IV or VII for sodium dichromate(VI). Benedict's test was usually correctly given as a means of distinguishing between butanal and butanone, but bromine water and sodium carbonate were encountered frequently as appropriate reagents. In (c)(iv) most knew the correct reason why methanol molecules cannot be dehydrated in a similar manner to the other members of the homologous series, but it was disappointing that many candidates gave cursory responses such as "because methanol only has one carbon atom", or "methanol cannot form an alkene" without appreciating that both of these facts would be required for a full answer. In (d) the majority gave a correct molecular formula for the alcohol F, but a few gave $\text{C}_{11}\text{H}_{21}\text{OH}$, which was not accepted. There was generally an excellent

understanding shown of the classification of this compound as a secondary alcohol. The expected answer to (d)(iii) was based on the results of experiment 2.2a in the Students' Book, and although some candidates gave answers based on the relative strengths of hydrogen bonding and Van der Waals forces between the alcohol and water, full credit was given for a simple answer based on the fact that only simple alcohols, e.g. those containing up to 3 carbon atoms, tend to dissolve, and that the solubility falls off as the alcohol becomes more complex.

Question 7

Candidates found little difficulty in classifying element R as belonging to Group 1, and in giving appropriate evidence to support this classification. However in (b), though the majority gave a reasonable value for the third ionisation energy of S, very few predicted a suitable value for the first ionisation energy of T, forgetting that since R was in group 1, T would be in Group 3 and therefore the most energetic electron would be entering a new p subshell, resulting in a lower value than the 738 kJ mol^{-1} value given for S. The expected answer for (c) was given only very occasionally. The majority simply stated that Q was a noble gas without any explanation as to how this decision had been made. An alternative answer which was reluctantly accepted was that Q had the highest first ionisation energy of all the elements in the table, but those giving this answer almost certainly failed to appreciate that a high ionisation energy is only one of several considerations to be taken into account when predicting relative reactivities. Candidates were on familiar ground when it came to writing an equation corresponding to the third ionisation energy for R, but, as in the past, examiners still found it hard on occasions to distinguish between "s" and "g" for the state symbols. Candidates are strongly recommended to write a "g" very clearly to avoid ambiguity. Part (e) was answered rather disappointingly and answers expressed with appropriate clarity were in the minority. Vague references to "screening" without demonstrating what this involves were not credited. A large number of answers simply referred to electrons in general without mentioning that the one being lost would be in the outermost shell.

Question 8

In (a) the commonest mistake when giving the electron configuration of a nickel atom was to assign the most energetic electrons to a 4d, rather than a 3d orbital, or to place all 10 electrons following the [Ar] configuration in the 3d orbital, i.e. $3d^{10}$. The calculation of the relative atomic mass of nickel in (b) was carried out successfully on the whole, but several candidates spoilt their answers by giving units to a value which is dimensionless. The calculation of the volume of carbon monoxide in (c) was handled well by the vast majority and here the commonest error was a failure to multiply the number of moles of nickel by 4 to give the number of moles of carbon monoxide. The construction of ionic equations remains a difficult exercise for so many students, and very few scored the mark in (d)(i). The commonest mistake was to write H_2^{2+} on the left-hand side as if the hydrogen atoms in the sulphuric acid molecule are inextricably linked together. A very large number of candidates gave the flammability of hydrogen as a hazard during the preparation of nickel(II) sulphate, but then wrote that the experiment should be carried out in a fume cupboard as an appropriate precaution. Several appreciated that nickel powder might be a hazardous material but then went on to say that wearing goggles would be a relevant preventative measure following on from this, as if the wearing of eye protection would not be worn as a matter of course when adding a metal to an acid. When answering questions of this type it is

recommended that candidates are taught to link hazards with associated precautions. The isolation of dry hydrated nickel(II) sulphate from its solution was described very poorly by so many candidates and this is all the more disappointing in view of the fact that salt preparation forms an intrinsic part of Topic 1 and that this type of question has been asked so many times before. It is regretted that the use of a "slight excess of dilute sulphuric acid" might have puzzled a few candidates. This was necessary to minimise salt hydrolysis. However, some appeared confused and wrote about the need to filter off the excess sulphuric acid. Some enterprisingly added a little more nickel until the reaction was completed and then filtered off the remaining nickel before carrying on with the crystallisation process itself. So many answers omitted to mention that heat should be used to reduce the volume of the solution, and in the next stage there were so many who described the solution as being left to "cool and dry", rather than to "cool and crystallise", when it was clear from the ensuing description that liquid was still present afterwards. In (d)(iv) the calculation of the maximum mass of crystals obtained was undertaken successfully by most.

Question 9

This was the least successfully answered question on the paper. In (a)(i) many failed to follow instructions and used 26g, or even 1g instead of 25g for the appropriate mass to use in the calculation. So many answers in (a)(ii) gave an answer to just one significant figure, even though the mass of calcium hydroxide and its molar mass had been quoted to three figures, and in the subsequent calculation, the majority either failed to appreciate that these reactions were exothermic and needed negative signs, or ignored the instructions to quote their answers to two significant figures, even though this requirement had been emboldened on the question paper.

The application of Hess' Law was usually correct in (b)(i), but so many lost marks through a failure to include a sign and units as given in the instructions. Full consequential marking was applied in all the calculations leading up to (b)(i) so that those who made mistakes at the various stages were not penalised more than once for each error. Part (b)(ii) was answered rather badly, with several candidates writing about inaccurate balances and spillage, without focusing on this particular experiment. The question explicitly referred to the use of a glass beaker, and it was therefore expected that as a comprehension exercise candidates would realise that its use would not only lead to extensive heat loss but also that its heat capacity would be considerable, as compared to the conventional use of a foam polystyrene cup. In addition there were many who resorted to mentioning examples of incompetence, such as failing to read a thermometer correctly or spillage of materials, as opposed to giving answers based on the use of insufficiently accurate equipment, notably laboratory thermometers reading only to 0.5°C. In (b)(iii) whilst the majority of candidates had little idea of how to answer this question, there were some impressive answers from a few. The difficulty of measuring the temperature in solids at a high temperature or of measuring the temperature change in a reaction that requires heat input formed the basis of many of these, and it was evident that some tried hard to apply their knowledge to the situation in hand rather than churning out generic responses.

Hints for revision

- Make sure that you learn and understand the various stages involved in preparing dry crystals of a salt from its solution in water.
- Practise writing ionic equations. There are generally three types which are required for Unit 1: those involving precipitation, neutralisation processes and redox reactions involving metals and acids.
- When carrying out calculations, quote answers to the same number of significant figures as those given in the data for the question. If one piece of data is quoted to a lower number of significant figures than is supplied for the others give your answer to this lower number of significant figures.
- When quoting enthalpy changes based on experimental results, look at the information given.
- If there is a temperature rise, then the enthalpy change must be exothermic and you must include a "-" sign when quoting the value you have calculated, even if your calculator doesn't show a negative sign.
- If, however, the temperature falls, then the reaction is endothermic and a "+" sign must be included in your answer.

6252/01

General

All questions in this paper proved accessible to some candidates but there were several unfamiliar situations which caused problems for the weaker candidate. A significant number of candidates started poorly as they were unable to complete the equation for the reaction between bromine and water in Q1(a)(i) even though they should be familiar with the reaction of chlorine with water and this hindered their progress for the next few parts of the question.

A recurring problem remains in the inability of candidates to read the question carefully, resulting in answers which gain no marks even though the chemistry is often correct. For example in Q1(c) the question asks for the test for bromide ions but this was misread as bromine and although a correct test was given such as decolorised by an alkene this of course scored zero marks.

The summary question was easy to understand but discriminated well because, to keep to the word total, only the stronger candidates were able to include sufficient detail to score key points 5 to 7.

Question 1

In (a)(i) the equation proved particularly difficult with very few candidates aware that either HBrO or BrO^- was one of the products. Those who included BrO often forgot the negative charge resulting in an oxidation number of the bromine as +2 rather than +1. Candidates should be encouraged to balance ionic equations in a two step process considering the atoms first and then the charges.

The calculation of oxidation numbers was generally well done in (a)(iii) and (b)(i) although disproportionation was not understood by some candidates who thought that it just meant the increase in oxidation of one element and the reduction of another one or failed to relate their explanation to this reaction as required by the question.

Ionic equations continue to present problems to many candidates. Errors abounded even in the relatively simple equation in (a)(iv) with, for example, chloride ions written as Cl_2^- and incorrect state symbols.

Part (d) proved challenging for all candidates. Few realised that chlorine was the most likely impurity in the gaseous bromine and could not think of suitable ways to remove the chlorine and water. Drying agents are not well known and it is surprising how many think that anhydrous calcium carbonate is a drying agent. A few candidates thought that this question had strayed from Unit 1 and described how you could crystallise out the bromine after evaporating some of the water.

Question 2

In (a) a surprising number of candidates have been so influenced by the publicity given to global warming that they believe air contains sufficient carbon and hydrogen to be a major source of synthesis gas and seem unaware of at least two from oil, coal and natural gas.

It is disappointing that there are still a significant minority of candidates who are unable to convert Celsius to Kelvin. Adding 298 was quite a common error but subtracting 273 to give a negative Kelvin temperature showed a complete lack of understanding of absolute zero.

In (c)(i) 'dot and cross' diagrams are now well drawn by nearly all candidates with very few omitting the lone pairs on the oxygen atom. However, the effect that these lone pairs have on the tetrahedral bond angle is still not well understood and a surprisingly large number of candidates are unable to show correctly what is meant by an angle indicating the 'angle' between two atoms rather than three.

Part (d) was very well answered by good candidates who often were able to suggest more than three advantages of the new method. Many weaker candidates misread the question and thought that the first equation referred to the old method and the second equation to the new method. As a consequence, an advantage of the old method was that you did not have to separate the methanol from water and an advantage of the new method was that less energy was given out. This resulted in very few marks for the candidate who misread the question.

Part (e) was generally very well done although in (iv) there are still candidates who think that any hydrogen atom, including those attached to a carbon atom, can form hydrogen bonds. Again although most candidates knew that the bond angle for a hydrogen bond is 180° they were unable to show the angle on a diagram, often just indicating an angle from the O to the H.

For some candidates the formation of carbon dioxide and water as the only products when an organic substance is completely combusted is still not known whilst others found the balancing of the oxygens difficult because they forgot the oxygen atom in the methanol. Some candidates thought that less carbon dioxide would be produced when methanol was burnt without realising that to get the same amount of energy more moles of methanol would have to be used than petrol, resulting in much the same amount of carbon dioxide. Others thought that methanol was the product of fermentation and hence renewable.

Question 3

Parts (a) and (b) were generally well answered although a few candidates were misled by part (a)(ii) where there were only two marks but three secondary compounds. Naming compound E proved a problem for some candidates who named it poly(propene) rather than naming the polymer after its monomer propene. It is also essential that candidates write clearly so that the letter e can be distinguished from the letter a.

Candidates who had learnt the reactions of halogenoalkanes had no problems with (c).

Good candidates who had studied free radical substitution reactions had no difficulties with (d) frequently scoring at least 4 of the 5 marks (but quite often having problems with the name 2,3-dimethylbutane). Other candidates seemed not to remember these reactions at all scoring at best one mark for termination. In the overall equation it is disappointing to report that the other product of this reaction, HCl was not known by many candidates.

Question 4

In this question, careful reading of the passage was necessary to be able to answer accurately several of the questions as well as completing the summary.

In (a)(i) it was surprising how many candidates thought that isotopes contain the same number of neutrons or have the same atomic mass. In (a)(ii) the passage does not say that all radon isotopes decay by giving out alpha particles but it does say that they are all radioactive.

The reason why radon is more hazardous than other decay products is simply that it is a gas whereas the others are solid. Some candidates got confused over the decay products of radon and thought that they were the gases.

Even though the question asked the candidates to consider the forces between both radon and water particles many candidates ignored this instruction and so lost one or both marks. Others misread the question and tried to explain why radon was soluble in water.

The calculations in (d) were generally well done. The only common errors which occasionally occurred were a lack of understanding of the powers on their calculators or a failure to multiply by 100 when calculating a percentage.

Whilst the passage was comparatively easy to understand it did not generate particularly high marks. Candidates were generally better at explaining how radon could enter the home but often used up too many words in describing this and so missed out key words when describing how the risk could be reduced. For example the word 'air' was missed out when describing how more bricks should be added beneath the floor or the addition of extractor fans as well was omitted. Others did not imply that these additions should be made below floor level. The passage stated that the risk was highest at night and in the winter but few candidates interpreted this to suggest opening windows at these times. Only a very few candidates were worried because they lived in Devon or Cornwall. Although the quality of written communication was reported as better by most examiners, there were some surprising mistakes with granite being replaced by graphite and/or thought to be porous and radon replaced by random.

There were few word penalties although there are still some candidates who lose most of their key point marks by writing in excess of 140 words and others who lose the QWC marks by answering in bullet points.

Hints for revision

- Learn the effect of lone pairs on bond angles and also how to show angles on fully displayed formulae.
- Read the question carefully and make sure you answer the question actually asked on the paper and not a different one from a previous examination.
- Learn at least one drying agent suitable for every case such as anhydrous calcium chloride which will not react with acids or alkalies
- If asked about solubility, consider the intermolecular forces between each substance separately before considering what forces there will be between the two substances when they are mixed.
- Remember that hydrogen bonds are usually stronger than dipole-dipole interactions which are usually stronger than van der Waals (London) forces (unless the molecule is a giant one).

6253/01 Coursework

The improvements identified in previous years in the quality of the submissions have been maintained although a small number of centres still experienced problems and some adjustments were deemed necessary. The general standard of the submitted work was excellent although again the number of candidates scoring full marks was small and there was a very good spread of marks in all the areas of assessment

Centres are again reminded that only the assessments used in the profile should be submitted **not** a complete record of the candidate's work. The coursework must also be collated as individual candidate profiles with a record sheet attached as the front cover. A copy of the record sheet is included in Appendix A. It should be noted that both declarations on the record sheet **MUST** be signed. One or two centres failed to do this again necessitating the return of the relevant items and a delay in the moderation process.

There were still a number of both addition and transfer errors. These included incorrect addition of the marks awarded for a particular exercise, incorrect totalling and number transposition. Please be aware that centres hold responsibility for the marks submitted although moderators will always help if at all possible. Centres are encouraged to ensure that all the relevant administration is correct and submissions fully documented. Any need to contact a centre can slow down the moderation procedure.

The majority of the marking had been carefully carried out with a clear allocation of the marks, and the annotation was generally excellent. In particular the use of the lettering system in the Design exercise is particularly helpful for moderation. However there are still a small number of Centres who do not do this with the result that moderation is far less straightforward. Most centres supplied appropriate 'tick lists' and only a small number failed to provide details of melting points, boiling points and yields for the preparative exercises. Details of the raw marks and indeed the candidates' actual work in all of the assessed 'carrying out' and the 'processing' assessments is helpful when considering a profile as a whole. In such exercises as C1 the submission of the candidates actual work should be regarded as a requirement.

Internal moderation continues to be vital and there is clear evidence of thorough and accurate procedures being adopted in most centres.

With a small number of exceptions all the profiles covered the correct specification descriptors with the exercises being drawn mostly from the exemplar booklet. Centres are reminded that Edexcel must verify new exercises.

Where exemplar material is used the temptation to alter mark schemes is inappropriate and should be resisted. There were again a few examples of the 'easing' of the mark schemes, but centres are reminded that the mark schemes must be applied firmly. Many of the required responses are quite precise and should not be 'eased' in any way. Typical 'easing' include the non-existence of key words such as i) **saturated** salt solution, ii) **anhydrous** calcium chloride (or drying agent), and iii) **heating** in the use of Benedict's solution (this latter being the most frequent). Care should be exercised to ensure that the saturated salt solution is added at the correct stage and that inappropriate anhydrous substances are not

used (e.g. anhydrous copper chloride). Occasionally candidates were given credit for the correct responses presented/detailed however in an incorrect order. All these occurring in D5. Care should also be taken with exercises which have 'sub maximal' as in C1 where there is a maximum of three out of possible four marks in section 4 and in C2 where there are two maxima of six and four marks.

Centres are asked to note that in those assessments where there are more than 15 marks available candidates who achieve more than this should be awarded 15. There were still a few centres that incorrectly deducted marks from 15 for every mark not achieved. For example, those with 16 correct points out of 17 were awarded 14 rather than 15.

C2 continues to present some difficulties in both marking and moderating and there is still a tendency to allow a measure of imprecision here and there. Clear accepted for colourless and soluble instead of recording the rise of water in a tube are particular examples although this year these errors were much less frequent. There were also less instances this year of the award of 2 marks for the effect of ammonia gas on the gases produced by the action of concentrated sulphuric acid on the halides rather than being awarded for the recording of the mistiness or white fumes observed as a result of the reaction between the halides and phosphoric acid without the use of ammonia gas.

In C4 there were a small number of instances where exothermic was accepted as 'gets warm'. Strictly of course this is a deduction rather than an observation.

The most problematic areas continue to be the assessment of both errors and safety in the processing exercises where again there were some acceptances of very weak responses. This was particular the case in both P1 and P2. The consideration of errors in particular is a difficult area for candidates at this stage of the course, which would tend towards a measure of leniency of interpretation but care must be exercised to avoid the award of the maximum marks for trivial comments. Comments which deal with 'human errors' (e.g. the inability to read a pipette or burette or losing some of a sample) should not be rewarded. Correct comments should focus on procedural and measurement errors. Additionally the responses to question 10 in P1 were often liberally treated. The response here requires a clear statement that 6 moles of H^+ are required for each mole of iodate.

It is important to remember that the C and P exercises must be carried out under strictly controlled conditions and generally completed in one laboratory session. In particular candidates should not be allowed to take the P exercises 'home' for completion. **Under no circumstances should the C and P exercises be carried out other than individually.**

Teachers should also note that candidates who wish to re-sit the coursework unit will require a new record sheet and must submit coursework marked in accordance with the guidelines that are operating at the time of the submission. The submitted profile must meet the specification requirements but can be a mixture of new and previously submitted assessments. It is NOT acceptable for the same assessment to be repeated to improve the mark. **ALL** of the work used for new candidate profiles **MUST** be available for moderation.

6254/01

General

The paper provided candidates with the opportunity to show they have a broad recall of most organic reactions from this part of the specification, they are adept at calculations but find it challenging when asked to describe and explain chemical concepts.

Question 1

This question provided many candidates with a sound start to the paper and responses showed that most are able to recall the key reagents and reaction types in benzene chemistry. Weaker candidates found it difficult to draw a structure for methylbenzenesulphonic acid in (a)(ii). A common error was to suggest that a $-SO_3$ group had attached to the ring and for those who realised the attached group was $-SO_3H$, a significant minority thought the group bonded to the ring via an oxygen atom. Perhaps surprisingly, given that the majority knew that methylbenzene is likely to be attacked by electrophiles, less than 50% of the candidates realised the attacking species in (b)(ii) was NO_2^+ , with negative nitrate and nitrite ions being common incorrect responses.

Part (c)(ii) proved to be more challenging. More able candidates were able to use the information in the question to recognise methylbenzene was more reactive and propose an argument based on the ring's increased susceptibility to electrophilic attack. However many responses did not consider the mechanism of attack and proposed answers based solely on the idea that 'benzene is stable due to delocalisation' were commonplace and rarely creditworthy.

It was obvious that most candidates were familiar with Benedict's test in (f), and had been well trained in giving full observations. The majority of candidates who chose this test scored full marks. The other most popular suggestion was Brady's Reagents, which again scored well.

Question 2

This question as a whole proved to be more demanding for many candidates.

In (a) very few candidates suggested appropriate methods, often suggesting techniques that involved studying the change of a reaction property over a significant period of time rather than a measure of the initial rate. Hence answers that used colorimetry to study the change in colour intensity over a period of time often failed to score credit.

Part (b) though showed that whilst candidates may not always understand the practical procedures they are using in kinetics experiments, they can interpret the data obtained. Many answers correctly deduced the order with respect to all three species involved often with a sound justification. Errors in rate expressions were rare, most commonly an omission of k , and most candidates were able use the expression to determine a rate constant, although some candidates seem to have difficulty in manipulating indices in order to determine correct units.

The plotting of the graph in (c) in general showed a lack of care. Although the basic structure of the graph was often correct, errors and omissions were

commonplace. This was especially evident on the x-axis where candidates failed to give units or the correct power of ten. Processing the data to determine E_a proved difficult for many. A number of weaker candidates ignored the advice to use the graph and tried solve to equation by inserting a set of data from the table into the Arrhenius expression. Those who did realise the importance of the gradient often obtained a sensible value but made errors regarding units and significant figures despite the guidance in the stem in the final conversion to E_a .

Question 3

For the most part calculations were done successfully in (a). Whilst in (a)(ii) recognition that the reaction would become more disordered was often seen, many answers were too generalised and did not take into account both the number and state of the reactants and products. Part (a)(v) revealed a common misconception that the thermodynamic likelihood of a reaction is the same as how far it goes. Hence many responses simply stated ' ΔS_{tot} is large so the reaction is spontaneous' without considering the extent of the reaction. In (a)(vi) more able candidates easily corrected the two errors though some weaker responses failed to correct two errors, leaving the final energy level of the products the same as that of the reactants. A very small number of candidates seemed to confuse this type of reaction profile with a Boltzmann distribution graph.

Part (b) showed that the majority of candidates find equilibria involving partial pressures problematic. Often weaker candidates failed to score in (b)(ii), with some adding their partial pressures together. Many candidates correctly worked out the mole fraction and unit for K_p but then failed to work out the partial pressures by multiplying by the total pressure, merely putting the mole fractions straight into the K_p expression. A surprising number could not work out K_p even if they had worked out the correct partial pressures, perhaps implying that some candidates could benefit from making themselves fully aware of how to use their calculator to process extended calculations. Interestingly candidates were far happier in using equilibrium constant how far a reaction had gone than ΔS_{tot} . Many muddled answers were seen in (b)(iv) with lots of candidates still believing that K_p changes with pressure. Even those who did realise K_p remained unchanged could not always justify it. The effect on the partial pressure of NO_2 was more clearly expressed, with the best responses applying Le Chatelier's Principle to arrive at an answer.

Question 4

Candidates seem very comfortable when handling pH calculations and a large number of fully correct responses were seen in (a)(ii). In addition the vast majority identified trichloroethanoic acid as the acid with the lowest pH because of its large K_a in (a)(iii). A small number ignored the standard form and hence proposed dichloroethanoic acid as the acid with the lowest pH. Very few candidates realised that the chlorines would stabilise the resultant anion, instead suggesting that they would destabilise the parent molecule making hydrogen ion dissociation more likely.

The recent improvements in the understanding of the structure and chemistry and esters was again evident in (b), with many correct structures and names given in (b)(i) and (ii). In (b) (iii) a number of candidates made good use of diagrams to explain how the methanol attacked the acid and this should be encouraged. However a few candidates still suggested erroneously that the methanol was acting

as an electrophile attacking the carbonyl carbon. In addition some proposals believed that an electrophilic carbon on the ester attacked oxygen on the acid. Despite a reasonable proportion of candidates realising that the ester needed hydrolysing in (b) (iv), few could suggest precisely how to do it, often suggesting that to reflux with simply water would be sufficient.

Hints for revision

- Make sure when you carry out a practical in class that you understand the principles behind the method as well as what your results might tell you.
- Remember to learn all the organic reactions from the specification, not just the ones from recent exams.
- Double check the detail in all calculations and graphs to make sure you have appropriate units and significant figures.
- Practise using your calculator to carry out multi-stage calculations.

6255/50 Coursework

There was again a high proportion of excellent work with candidates clearly becoming very involved with their investigation and teachers awarding much of the work at the appropriate level. The quality of work at all levels again seemed to show an improving trend since last year.

Nevertheless some problems continue to occur falling basically as before into two categories:

- An inappropriate topic or an appropriate topic approached in an inappropriate way
- Some crucial misunderstandings by candidates.

A good investigation should be based around an appropriate amount of manipulation with ideally a number of different skills displayed. It should also be appreciated that there is little extra merit in repetitious simple exercises. Ideally candidates should be encouraged to think clearly about what they really need to do.

The record sheet should be attached to the investigation as the front cover of the work. Both declarations on the record sheet **MUST** be signed.

Planning and Implementing

It should be appreciated in the planning category that to access the higher marks something rather more than a series of practical instructions is required. Any investigation should be tied as closely as possible to the relevant theory and any specific techniques should be justified. The specific amounts to be used must be clearly and fully justified; it is not enough to refer vaguely to previous experiments or to information gleaned from the Internet. It is also important to indicate how it is intended to process the results obtained. All preliminary work should be fully recorded since in some cases this can make a significant contribution to the quality of the investigation.

Candidates should be discouraged from making predictions (a GCSE 'hang up') since the essence of a good investigation is that the result is not known to the candidate or indeed at all.

Candidates should obtain results, which cover as wide an area as possible showing appropriate repeats since this will allow an assessment of the repeatability of the experiments.

Concluding and Evaluating

For high marks both aspects must be addressed. A conclusion should be made and candidates should be encouraged to focus completely on their results and not seek to justify either a fallacious prediction or a perceived result. The evaluation should focus on the overall accuracy of the results particularly concentrating on the reliability of the apparatus used and the perceived repeatability of the experiments. If the aim is to quantify the experiment by calculating percentage errors this should involve rather more than a list of the percentage error of each of the individual components without consideration of the circumstances of their use.

All exercises of course will not allow for the same degree of numerical analysis but appropriate qualitative discussion could have equal value if appropriate.

The 'risk assessment' should be specific to the experiments to be carried out and be more than a list copied from standard risk data. Statements such as 'solid magnesium chloride is corrosive' are meaningless in the acid/magnesium investigation.

The GPC submissions again showed an excellent range of marks. This form of assessment does provide a candidate who finds investigations challenging with the opportunity to achieve a reasonable mark, which reflects his/her general approach to practical work throughout the A2 course, and hence enhance the overall mark. While there are no specific requirements for centres to provide details of how the assessment is determined, the moderators would welcome any information in this area. Setting the comments against the criteria might be an appropriate method. It would be particularly helpful in those cases where there is a significant non-correlation between the GPC mark and the mark awarded for the investigation.

An important feature of an extended piece of work such as an investigation is the teacher input and whether any comments other than the approval or otherwise of the risk assessment are appropriate and/or desirable. The planning phase is clearly vital for overall success. There will be candidates who do find this quite challenging and it might be appropriate therefore for the teacher to give some assistance to allow the candidate to proceed. Help cards are a useful way to ensure that consistent advice is given to each candidate. Consequently of course the planning mark would be reduced appropriately and this noted for the submission for moderation. Teacher assistance might also be appropriate in order to prevent a candidate from embarking on a flawed experimental technique or a flawed analysis. A flawed plan if carried through will necessarily have a flawed analysis and the overall effect on the marks can be quite significant. Centres are encouraged to ensure that all students are issued with the 'Student's Guide' incorporated in the Coursework booklet (pages 81 to 90). Not only does this contain the assessment criteria but there is a brief section on the treatment of errors.

Teachers are reminded that collaborative work is NOT permitted for any aspect of the investigation. Evidence of collaborative work will be referred to Edexcel as a disciplinary matter.

Metal/H⁺

Seemingly just as popular as last year the acid/magnesium exercise (the alternative using zinc was only occasionally used but this was generally rejected because of the slow rate of reaction) continues to be the preferred choice for many Centres. The investigations ranged from the outstanding to those of a very limited standard.

In a large number of cases the preliminary work in particular was excellent with a thorough and full justification of both the techniques and amounts used.

As a 'tool' for analysis a candidate would be expected to perhaps measure volumes of gas against time and control the temperature even if the activation energy is not being investigated. A common error in this was to carry out a complete volume vs time experiment with a range of acid concentrations when the whole range could

be investigated of course with an appropriate experiment starting with 2M acid and an excess of magnesium. This would then allow a candidate to obtain repeat results, something, which some candidates fail to do.

As before the techniques used in this investigation included:

- (i) Measuring the volume of hydrogen produced as a function of time either to completion to some pre-selected point. This method was quite common but often it involved an extensive collection of volumes and times only to use them to draw a gradient at 0,0.
- (ii) Measuring the time for a piece of magnesium to disappear. Again fairly common with a wide range of masses of magnesium.
- (iii) Taking samples at timed intervals and titrating the remaining acid.

For the first time the 'loss of mass' method did not feature this year in the moderated samples.

There were still a number of crucial misconceptions, which in some cases significantly altered the ability of a candidate to achieve appropriate results. Encouragingly these were even fewer in number this year. It was not made clear in these cases as to the precise requirements in terms of the quantity of chemicals required for the two techniques available (the 'initial rate' method or the 'continuous' method). Candidates just gave amounts of the acid and the magnesium based on 'previous experience' and where calculations or preliminary experiments were carried out the focus sometimes was on obtaining a 'reasonable' rate.

Candidates need to make it very clear that if the 'initial rate' method is to be used the assumption is that during the short duration of each experiment the concentration has to remain as constant as possible and in fact it is assumed not to change at all. The 'initial rate' also implies a relatively short elapsed time, some candidates were again happy with times running into several minutes. Having carried out an 'initial rate' method some candidates then proceeded to plot a graph of concentration against time rather than rate and then proceed to evaluate half-lives. This method of course is completely invalid since the data is discontinuous and leads rapidly to contradictory conclusions. Again encouragingly the numbers going down this route this year were fewer in number.

Some candidates again this year seemed unaware that if the 'initial' rate method is used it is not necessary to record large numbers of results in the form of increasing volumes and times for a particular concentration. Such an unnecessary procedure is time consuming and can restrict the time available for other considerations.

If a $V_f - V_t$ method is to be used with a view to a consideration of half-lives it is vital that an excess of magnesium is used otherwise any attempt to calculate half-lives is flawed and again will lead to erroneous conclusions. Ideally the excess of magnesium should be clearly confirmed by calculation and not left to the marker/moderator to work out.

For candidates who carried out such a continuous method some problems arose with the relative amounts of chemicals used and a lack of understanding as to the consequences of a particular choice of relative amounts. Some very small volumes of acid were used (less than 5 cm³) usually of relatively high concentration. The consequences of the subsequent quite exothermic reaction was not always fully appreciated or dealt with. Some excellently justified plans to utilise an excess of

magnesium were nullified by a late change to a large volume of acid in order to limit the temperature rise. Some candidates however were not only aware of the exothermicity but monitored it and made appropriate corrections.

While the use of computer-generated graphs is to be encouraged these should be used with caution. Often the graphs were too small with very thick lines and not an inappropriate 'lines of best fit'. The points on the graph represent information, which is of variable accuracy, and this must be reflected in the graph drawn.

Being a very numeric exercise error analysis can be quite quantitative and many candidates either calculated an overall percentage error or utilised bar lines on the appropriate graphs, both to good effect.

At this level it would be inappropriate to expect too much detail regarding any reaction mechanism since often the rate appears not to be of a simple whole number order. The fact that an order and/or an activation energy value can be obtained certainly points towards a confirmation of the standard theory usually dealt with in the plan. If the activation energy concept for example was invalid no linear relationship would be obtainable. Where there is a discussion of mechanisms care should be exercised to ensure that this is relevant to the results obtained. 'Internet' data is often quite inappropriate for the exercise under consideration and should be avoided.

Vinegar

Again almost no straightforward titration exercises were seen this year in this investigation. Most coupled titrations to a distillation (to allow the separation of the more volatile ethanoic acid) and a chromatographic exercise or inorganic analysis. The distillation allows a comparison to be made between the ethanoic acid present and the total acid content of course. A useful strategy is to prepare vinegar containing specific measurable amounts of other less volatile acids and some colouring matter.

Other Topics

Other areas of investigation ranged from 'laundry bags' through enzyme activity to a consideration of the preparation of various organic substances, many of these being of excellent quality. The use of analytic techniques not normally available in centres is to be encouraged if local access can be arranged. There must of course be sufficient opportunity for candidate input in both the use and analysis of results.

Some centres (sadly again only a small number) took the opportunity to base their investigations on the Special Studies with some interesting results. There is continued hope that in the remaining two years of the specification more centres will utilise the Special Studies now that exemplar briefs are available for all of them.

Centres are encouraged to evolve their own exercises based on the published criteria and of course any new views would be much appreciated.

However as an Investigation is an A2 exercise care must be taken to base any investigation on the A2 part of the specification. Any enthalpy exercise therefore is inappropriate unless based around the concept of Lattice Energies. Other areas to avoid if high marks are to be achieved are the straightforward 'closed' exercises

such as the simple determination of the formula of a complex ion, a simplistic comparison of 'antacid tablets' or a simple analysis of a metal sample.

6255/5A-5E

The aim of the Special Studies is to introduce students to some of the ways in which chemistry is used in related disciplines. In the short space of time available we cannot hope to turn students into Materials Scientists, Chemical Engineers or whatever but we can give them a practical taste of the role of Chemistry in these subjects. In doing so we can reasonably expect students to think about the relationship between the Studies they are doing and the ideas in the main course. To put it briefly, a student doing a Special Study should 'think like a chemist'. This remark probably applies with most relevance in the Biochemistry and the Food Science where, because of their other subject choices, students may already have been encouraged to 'think like a nutritionist, biologist etc' and to relegate chemical detail to a secondary place.

Biochemistry

The first three parts of (a) were generally well answered, though examiners were kept on their toes in spotting 'adenine' in place of 'adenosine' and 'carboxyl' in place of 'carbonyl'.

Part (a)(iv) was a considerable disappointment from the majority of candidates. Many immediately started to discuss 'energy' instead of 'entropy'. Had they been asked to discuss the feasibility and rate of any other reaction than a biological one, the success rate would in all probability have been much higher. As it was, they were obsessed with the question of energy supply instead of concerning themselves with the reactions themselves.

The simazine question was confidently answered by the well-informed. Those who had to speculate came up with some very strange theories including a gene for destroying simazine and a basic similarity between all weeds which made them susceptible.

In (b) hydrolysis was more often than not correctly explained and students either recalled the experiment or similar ones, giving a sensible way of estimating rate, though some did suggest plotting graphs of various kinds. It might be helpful to candidates to be reminded that if the question, such as (iii), begins: 'Suggest....' they are not being asked for a cut-and-dried prepared answer but for a plausible explanation which fits the facts. References to pH dependence did not gain credit here.

Answers to (iv) revealed some uncertain understanding giving examiners problems in dealing, in the same answer, with correct 'proton acceptor' but a formula written with no + sign. Sympathy normally prevailed but with the greatest of misgivings. There were some horrors such as the assertion that ammonia and carbon dioxide would result from proton acceptance and donation respectively.

Good answers to (v) generally came from whole centres where candidates had evidently 'thought like chemists' by considering the *nature* of attractions between protein R groups and between charged groups and substrate molecules. By this stage, candidates really should have moved on from 'lock-and-key' explanations for active-site behaviour.

All three parts of (c) were answered well, in general.

In (d)(i) the expected answers, animal experiments taking longer and being more expensive, were seldom seen, candidates preferring to go down the route of 'public objection to animal experimentation'. This route did not normally obtain credit unless accompanied by some understanding of why it results in slower progress.

Considerable latitude was allowed in (d)(ii). There are two good examples in the student text but others were allowed and were often forthcoming. It was encouraging that where candidate suggestions were checked, the suggestions turned out to be genuine. From weaker candidates, responses often failed to mention genetic modification of animals or other organisms, instead insisting that the patients were being genetically modified.

Methods of making insulin by using yeast and by using bacteria were both accepted. Many candidates did not mention a role for the glucose and the third mark, for which there were two distinct possibilities, was seldom awarded.

Chemical Engineering

As is normally the case, high-quality answers were seen, this Special Study often seeming to be undertaken by enthusiasts. It may be of relevance that where the practical work is done by groups of students, everyone in each group should be encouraged to participate in all the activities; there were occasional indications that some candidates were unfamiliar with CSTR calculations, for example.

The first three parts of (a) attracted good answers though occasionally a mark was lost in (ii) by those who did not appreciate that pumping in streamline flow requires *less* energy than in turbulent flow. The significance of the boundary layer to heat transfer was frequently pointed out.

The operation of 'scrubbing towers' was less reliably understood than the advantages and disadvantages of packed fractionating columns.

In the calculation in (b)(i) the most frequent error was to confuse '% conversion' with '% remaining unreacted'. The 'transferred error' principle was applied here so that wholesale loss of marks was avoided.

Whilst many realised in (v) that conditions are steady in continuous operation, few explained clearly that variations from the norm could be electronically detected and corrections (eg to flow rates) automatically applied.

In (c) (i) answers tended to focus repeatedly on the need for safety without making it clear why this would have practical implications, economic ones in particular.

In the final two parts heavy chemicals and raw materials were generally distinguished successfully though some candidates did not make it clear that heavy chemicals are not only made in large quantities but are used to make a variety of final products.

Food Science

In (a) candidates were expected to recognise significant linking groups and it was rather disappointing to see so much ignorance of these. Peptide links sometimes had 5-valent carbon atoms or 4 valent nitrogen atoms and sometimes were quite

unrecognisable. Disulphide bridges sometimes had double bonds and ester and glycosidic links were often quite wrongly represented. It was not intended that (a) should identify moderate-to-good performers but that was how it worked out, better candidates showing not only the linking groups but also their contexts.

Whereas (b)(i) was familiar ground, (b)(ii) was much less familiar with muscle contraction and rigor mortis sometimes being explained as a moving apart of actin and myosin and a complete disintegration of muscle tissue respectively. In (b)(iii) bitterness was often confused with sharpness/acidity and whereas chlorophyll was easy to state in (iv), the second mark for loss of magnesium ion or destruction of phytol/ porphorin was seldom awarded.

Part (c) went well for many candidates with the calculation being either derisively easy or almost impossible.

With only one mark available for each method in (d)(i) it was important to hit exactly the comparative interplay of time and temperature and although considerable latitude was allowed for both of these factors, marks were lost because essential differences were not spotted. Part (ii) went much better with a wealth of detail from many candidates.

The final two parts were generally well answered although ethanoic/acetic acid sometimes gave place to other interesting alternatives and it was not always clearly explained that lactic acid is a by product of the cheese-making process itself whereas ethanoic acid does not come from the onions but is added from an external source.

Materials Science

The various parts of (a) were patchily answered with most knowing about the nature of the aluminium oxide layer though some used its existence to answer (iv) as well as (i) and missed the point that aluminium has only one oxidation state in its compounds. In the equation the commonest fault was to give the oxide ion as O^- which had the unfortunate effect of losing both of the available marks.

There were many good answers to (b). Part (i) was intended to be an easy starter and there were several ways of acquiring the marks in (ii) and (iii) but to get full marks the idea of electrons being supplied by the sacrificial anode to suppress the oxidation of the iron had to appear somewhere.

The castings in (c) were well described with the majority of candidates getting at least five marks on (i) and two more on (ii).

The first three parts of (d) were evidently well rehearsed and scored reliably. Part (iv) was less confidently done with many candidates simply quoting data as being 'high' or 'low' without saying what the practical effect would be. Hoped-for subtleties such as 'glass-fibre has a low density but because it lacks stiffness a car body would have to be made of thick material which partly offsets the weight advantage' were seldom in evidence.

Most candidates picked up a mark for the final point.

Mineral Process Chemistry

It was encouraging to see more candidates for this Study and even more so because several were of high quality.

In (a) candidates were much more aware of the definitions at the core of the subject than has sometimes been the case in the past. In explaining the formation of hydrothermal deposits few attached proper significance to the fact that in order to achieve high temperatures the water is under pressure.

Just as in other Special Studies, students should be 'thinking like chemists' when carrying out the practical work and the chemical detail required in (b), though rather more accurate than in the past, was still a little disappointing.

Candidates seemed to have little trouble with (c)(i) but in (ii) elementary errors included not putting in any detergent and not indicating that air bubbles are deliberately introduced, they don't just appear. In order to get the third and fourth marks candidates had to appreciate two main things as the basis of an answer. Firstly that the mineral particles consist of ionic species and therefore have charges on them and secondly that a detergent particle has a charged end and a hydrophobic hydrocarbon end. Discussion of detergent action has a place in some GCSE specifications but is not referred to in the main Nuffield text. It's all there in the Special Study of course but teachers (and students) need to be aware that this is not particularly familiar ground and that class discussion might be needed.

6256/01

The paper seemed to be well received by the candidates with its greater variety of question types, including some multiple choice items for the first time. There was no evidence of candidates having insufficient time to finish the paper. There were the usual problems of failing to read the question and accuracy of expression in answers.

Question 1

The Born-Haber calculation in (a) was the simplest possible, and gave a positive start for the majority of candidates. An energy level type cycle, as at the top of page 385 in the Students Book, is always required. Book of Data values are needed. The Students Book has an incorrect value of $+349 \text{ kJmol}^{-1}$. Weaker candidates breathed a sigh of relief at the end of the calculation too soon and omitted to give the answer to three significant figures, failing to read the question.

In (b) the problem was the enthalpy calculation. Many candidates failed in this but still could get three of the four marks. There were few problems with (ii). In (iii) the examiners were pleased to see a few candidates giving a Topic 17 comment like 'because the total entropy change lies between zero and $-200 \text{ JK}^{-1}\text{mol}^{-1}$, the reaction is an equilibrium favouring the products, so silver chloride is only slightly soluble'. This is the desired type of comment, much better than the Topic 13 superficial comment 'as the total entropy change is negative the reaction is not spontaneous'.

In (c) and (d) most candidates were applying their knowledge in an unfamiliar context. Better candidates did not find this a problem. In (c)(i) it was important to give the reaction in the conventional way giving the oxidising agent, AgCl, first and to remember to include the added electron. Only better candidates realised the need to have the silver wire dipping into or coated with silver chloride in (ii). The need for chloride ions in solution and the cell conditions of concentration and temperature were well known.

Better candidates had no problems with (d). Weaker candidates could not get the entities in the correct order in (i), and looked up the incorrect value for the copper electrode in (ii) suggesting more practice in the use of the Book of Data is needed. Only better candidates managed (iii) realising the need to add 0.22V, but there were many sensible creditworthy suggestions in (iv), though candidates are advised to be as precise as possible in this type of question. For example 'it does not contain platinum' was insufficient but 'it is cheaper because it does not contain platinum' was fine.

Question 2

Part (a) tested those who omitted to read the words secondary or amine. Part (b) was fairly straightforward but (c) required a little thought - all secondary compounds of four or more carbon atoms in a straight chain are chiral. None of the reactions in (d) were well known. The test for halogenoalkanes in (i) is important. Reactions in (ii) and (iv) are all from Topic 18 amines and amino acids. Part (iii) combined Topic 18 amino acids with Topic 10 halogenoalkane reactions. Topic 10 halogenoalkane and Topic 8 alkene reactions were needed for (v).

Part (e) tested the important reaction to form amides from Topic 18. Better candidates were able to manage the name in (i). Only weaker candidates could not manage the equation in (ii) either not knowing the reactant or omitting the inorganic product.

Part (f) was also discriminating. Only better candidates can draw dipeptides. Some weaker candidates drew a part of a polypeptide chain. Others did not know the peptide link. In (ii) it is a good idea to stick the attachments to double bonds at right angles to the chain to avoid the need for placing them in additional brackets. Equations should have 'n' on both sides. Many candidates gave accurate conditions from the Students Book.

The understanding of nmr seems to be improving, though it still seems that this type of question discriminates better candidates. The justification 'fewest hydrogen environments' is one that should be learned.

Part (h) required familiarity with common bond absorptions in IR. Part (i) was the hardest part question on the paper. The work on halogenoalkanes seemed often to have been forgotten.

Question 3

Part (a) was well done with only a few candidates failing to give the full configuration by giving the rare gas core and outer shell electrons only, which was insufficient to gain the mark.

In (b) it is important that candidates orientate ligands correctly when drawing complex ion shapes, so the oxygen of water needed to be clearly bonded to the cobalt.

In (c)(i) chloride ion is the ligand. Many weaker candidates gave 'chlorine'. Some candidates lacked practice in writing equations for the formation of complexes and struggled with (c)(ii). Full credit could be gained for the equation using either chloride ion or hydrochloric acid. For the second mark it is necessary to give full information not just 'the entropy change of the system is positive because the number of entities increase'.

In (d) it was clear that many candidates were unfamiliar with the use of Table 6.13 in the Book of Data. The result was a variety of incorrect numbers of ligands from one to five in (i) and wrong values for the overall stability constant of this complex in (ii). Some also misread the stability constant for the edta complex - it is a good idea to place a ruler under lines of numerical data when reading them to avoid this. There was evidence of poor QWC in (ii). The **complex** with edta is more stable not 'edta is more stable'.

Homogeneous catalysis is well understood as shown by responses to (e)(i). In (ii) the key word is 'how' and not 'why', so answers needed to mention the oxidation of cobalt(II) by hydrogen peroxide and its subsequent reduction by tartrate. Good candidates were able to unravel the structure of the tartrate ion in (iii) from its systematic name.

Question 4

Only good candidates were able to fully handle the calculation of empirical formula from combustion data in (a)(i). Some worked backwards from later parts and gained credit for the correct empirical formula without getting the method marks. Making the method of calculation clear saved many candidates in part (ii) - 'n x empirical formula mass = molecular mass' was the key step.

Only good candidates were able to handle the relatively straight forward but seemingly unfamiliar type of calculation in (iii) to show that Z was a dibasic acid. Good candidates continued to do well in (iv) and (v). Some, who had not managed earlier parts, correctly or consistently deduced W, Z, and Y in (iv) by working back from a sensible equation involving production of a short chain alkene in (v). In (b) the reaction to form a diol from an alkene was only recalled by the best candidates. Throughout the question transferred errors were easily credited as the question was marked as a single item.

Hints for revision:

- Read the question twice before you attempt it and once after you have finished to check you have answered it.
- Practise accurate expression, especially in the use of the terms ion, atom and molecule, where 'entity' is very useful collective term
- Practise use of Data Book for enthalpy, entropy and electrode potential calculations, and extracting information about complexes.
- Practise calculations of empirical formulae from combustion data and titration calculations.
- Be familiar with the work of Topics 8, alkanes and alkenes, 9 intermolecular forces and 10, halogenoalkanes. Topics 8 and 10 are particularly important in synthesis and analysis questions.

Appendix A: Statistics

6251/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	46	41	36	31	26
Uniform boundary mark	90	72	63	54	45	36

6252/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	41	36	31	26	22
Uniform boundary mark	120	96	84	72	60	48

6253/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	50	46	42	38	35
Uniform boundary mark	90	72	63	54	45	36

6254/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	47	43	39	35	32
Uniform boundary mark	90	72	63	54	45	36

6255/5A + cwk (or 6255/5A + transfer cwk)

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	76	58	52	47	42	37
Uniform boundary mark	90	72	63	54	45	36

6255/5B + cwk (or 6255/5B + transfer cwk)

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	76	59	53	47	41	35
Uniform boundary mark	90	72	63	54	45	36

6255/5C + cwk (or 6255/5C + transfer cwk)

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	76	58	52	46	40	34
Uniform boundary mark	90	72	63	54	45	36

6255/5D + cwk (or 6255/5D + transfer cwk)

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	76	59	53	47	41	35
Uniform boundary mark	90	72	63	54	45	36

6255/5E + cwk (or 6255/5E + transfer cwk)

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	76	59	53	47	41	35
Uniform boundary mark	90	72	63	54	45	36

6256/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	40	36	32	28	24
Uniform boundary mark	120	96	84	72	60	48

Notes

Maximum Mark (Raw): the mark corresponding to the sum total of 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.

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