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Contents

6251/01

General

The paper produced a very wide range of marks. Many candidates were well prepared, and could think through unfamiliar problems. The organic chemistry question produced consistently high marks and candidates who were confident in handling numbers often gained full marks in Q5. However a significant minority had difficulty with some of the simpler questions. Basic facts about the Periodic Table were not well known, and explanations about ionisation energy proved difficult. The question on thermochemistry showed lack of understanding of the reasons for choosing an experimental method.

In calculations it is important to explain what is being done and there is a continuing tendency to write numbers without saying what they refer to. In some questions, such as explanation of periodicity, poor quality of written communication caused marks to be lost. As usual there were some problems with legibility. If answers are written in pencil, or carelessly, state symbols or similar words may be indistinguishable.

Section A

The equation in Q1(a) was well done, the most common error being failure to realise that oxygen is diatomic. The majority of candidates answered Q1(b) well, though it was disappointing to see calcium oxide shown as covalently bonded. The question asked for all electron shells to be shown, to avoid any confusion about how to represent the empty outer shell of the calcium ion, but a few candidates failed to do this, or showed the electron configuration of 2,8,8 for the oxide ion. Others showed electrons in transit from the atoms and did not make the structures of the final ions clear. Most candidates knew that calcium hydroxide formed in Q1(c)(i), but there was less certainty about its pH.

The rest of Section A caused difficulties. In Q2(a) many candidates seemed to have no idea of the likely magnitude of the answer, and were happy with answers of around 10^{-23}. Others knew the value of the Avogadro constant and tried to use it in their calculation in a rather circular argument. The impression given to examiners was that few candidates were thinking about whether their answers were realistic. Q2(b) showed that few candidates know the meaning of the relative atomic mass given in the Periodic Table. A large number of answers stated that “this is the most common isotope”, or suggested numbers of protons and neutrons in a particle of mass 80.

In Q3(a) it was apparent that many candidates were unsure of the difference between groups and periods. The work on the Periodic Table is done early in the AS year and many teachers will assume that basic facts about groups, periods and relative atomic mass are known from GCSE work. This may account for the problems in Q2(b) and 3(a). There were many good answers to Q3(b). The simple answer that electrical conductivity decreases across a Period (as elements change from metals to non-metals) was enough to gain the mark. Some candidates gave more detail, but many seemed to think conductivity increased across a period. Another common error was to describe only one side of the Periodic Table leaving the examiner to guess the rest.

Some answers described the trend going from right to left across a period and were given the mark if the description was correct, but it seems an odd way to think about a row of elements! Q3(c) produced a very wide range of answers, but to be accepted they had to be physical properties, so reactivity was not accepted though some properties, which, strictly speaking, are of atoms rather than material in bulk eg atomic radius, were allowed.

Question 4

This question was on familiar material and many candidates scored full marks. Nearly everyone could name propan-2-ol and explain why it is a secondary alcohol, the most frequent error being to say that the OH group is on the second carbon in the chain. The equation for combustion in (c) was challenging and products other than carbon dioxide and water were shown. The most common error in balancing was the failure to realise that propan-2-ol contained an oxygen atom, so too many oxygen molecules were used. Candidates were asked to use the molecular formula of propan-2-ol to make balancing simpler, but use of the structural formula was allowed. Observations were required in (d), so answers such as "hydrogen is given off" were not credited. There were many correct answers though some of the descriptions of sodium going on fire matched the reaction with water rather than with an alcohol. The colour change with sodium dichromate was well known, and so was the structure of the ketone which forms, though an extra hydrogen often appeared on the central carbon atom. The most popular suggestion for a dehydrating agent was aluminium oxide, and there were many good diagrams for the dehydration method. Errors included omitting heat or not positioning the heat under the dehydrating agent; sometimes the end of the delivery tube was drawn a long way from the collecting tube for the gas. A number of candidates who could not name the dehydrating agent showed aluminium oxide in the diagram, so presumably did not realise its function.

Question 5

There were many correct answers to (a) and suitable choices of indicator for (b), though often candidates thought that methyl orange was orange, rather than yellow, in alkali. The moles calculations in (c) and (d) were straightforward and well done, with a minority making arithmetical mistakes or using the molar mass of HCl in (d). In (d) 0.002 moles of acid reacted, so to answer (e) candidates simply had to scale up to find how 2 moles of acid would react, and credit was given for transferred errors from earlier mistakes. In (f) candidates had to look back at the equation which showed that one mole of sodium carbonate reacts with two moles of acid, so the molar mass equals the mass calculated in (e). Though this was unfamiliar, many candidates did succeed. In (f) the calculation could be based on the earlier answer or the alternative value given, and this scored more highly than the preceding two parts.

Candidates who were confident in working with numbers often gained full marks on this question, but it was testing for those who prefer routine calculations.

Question 6

Though many candidates can use Hess cycles, there is a lot of uncertainty about why experiments are done in particular ways. There were many possible allowed answers to (a) but the most common suggestion was that heat loss would occur, and this must have been given without visualising the experimental set-up in a thermal decomposition.

In (b)(i) many candidates gained the first mark by stating that powdering the calcium carbonate would speed up the rate of reaction, but did not explain that heat losses occur when a reaction is very slow. Another popular suggestion was that powdering the calcium carbonate ensures that the reaction goes to completion. The first mark was also given for this, although as the acid is present in excess the reaction would go to completion eventually. However the rate would be very low, so again an accurate temperature rise could not be measured because of heat losses.

Most candidates calculated (b)(ii) correctly, with only a few trying to convert the temperature change to Kelvin by adding 273, or giving the answer with incorrect units. However (b) (iii) seemed to gain either two marks or zero, as some had little idea of what to do with the data. Knowing that the units of enthalpy change are kJ mol^{-1} shows that a number of kilojoules has to be divided by a number of moles, so emphasising units may help candidates with calculations. Those who did calculate a value often forgot the negative sign for the exothermic reaction.

The first mark in (b)(iv) was for knowing how to apply Hess' Law, but some candidates did not use the symbols in the cycle given and referred to $\Delta H_{\text{reactants}}$ and $\Delta H_{\text{products}}$. This did not lose marks if the answer to the calculation was correct but again suggests that candidates are learning various rules and not applying them to the actual question. Part (c) was an easy finish to the question and scored highly.

Question 7

Part (a) was well done with only a few errors in explaining that sodium is oxidised. An observation was required in (b)(i) for the flame test for magnesium, so the answer "none" or "nothing" was not accepted, though "no colour" got the mark. Many candidates knew that there was radiation outside the visible spectrum, but this was not enough unless they made the observation that the flame does not change colour, or words to that effect. Descriptions of magnesium burning with a bright white light were sometimes combined with a flame colour, but this was not given credit.

In (b)(ii) the cause of flame colour was well known, and (b)(iii) produced many correct answers with a few wrong ones such as distress flares and neon lights.

Part (c) was well known and most candidates gave the configuration of the ion as requested, rather than the atom. Part (d)(i) was also well done, with the majority of candidates writing the equation for the formation of Mg^+. However examiners continue to have a problem when candidates do not write state symbols clearly and frequently (s) and (g) could not be distinguished and therefore a mark was lost.

In (d)(ii) many answers correctly said that magnesium had one more proton than sodium. However ionisation energy shows periodic variation – a link with Q3 – and does not increase steadily with the number of protons in an atom, so the second mark was for the important point that electrons in magnesium and sodium experience the same shielding, or are in the same shell. A disappointingly high number of responses were based on sodium having one electron in its outer shell and "wanting" to lose it more than magnesium. This is probably a legacy of explanations given at GCSE and needs to be addressed when teaching Topic 3.

Part (d)(iii) required careful thought and there were some very good answers. However many candidates did not realise that the second ionisation energy is always greater than the first. A common misconception was that, as Mg^+ has the same electron configuration as Na, it would have the same ionisation energy, despite the difference in the nucleus. Of those who thought the second ionisation would be higher, some thought the jump would be the same as for sodium and predicted values above 4000 kJ mol^{-1} without thinking about the shell from which the second electron is removed. There were many confused statements about electrons attracting each other. When the ionisation energy change between Groups 2 and 3 is studied, two factors operate - the effect of an extra proton and the start of a sub-shell of higher energy. However, many candidates think in terms of a pair of electrons in an s shell being stable, and therefore they cannot explain situations such as those in (d)(iii).

In (e) weaker candidates thought magnesium would be larger as it had more electrons, and again did not consider the effect of the nucleus. There were comments that the outer shell electrons repel each other and spread out to make the atom bigger, even though attraction between electrons had been suggested in (d). In this topic candidates should be encouraged to consider three separate ideas – the charge of the nucleus, the energy level of the electrons and the shielding of the outer electrons.

Hints for Revision

- Make sure you know the basis of the Periodic Table ie the difference between a group and a period, and the meaning of the numbers on the Periodic Table. The molar mass in the Table is the average molar mass of the isotopes of each element in the proportions they occur naturally. This is why the molar masses are not always whole numbers.
- Always make sure that you have not drawn too many bonds on an atom in displayed formulae. Check that there are no carbon atoms with five bonds in alkenes, aldehydes or ketones, where there are double bonds.
- Practise showing the method for every calculation you do. There should be some words with every stage eg “moles HCl” or “mass NaOH”.
- Practise giving answers in standard form so that you get used to putting powers of 10 into your calculator.
- When you explain changes in ionisation energy or atomic radius, think about three things – how many protons are in the nucleus? What energy level are the electrons in? How much shielding do electrons have? Atoms never “want” to lose electrons. Energy is needed to remove an electron and the amount of energy needed depends on the three things above.

6252/01

General

Candidates found this paper accessible with some challenging areas, especially when asked to justify or explain ideas. The calculations on the paper, though straightforward, were handled competently. Recall of key organic reactions was generally good but understanding how organic reactions occur and applying basic reactions to unfamiliar molecules was less well done. Candidates found the language used in the passage relatively easy to follow and as a result could access all of the available key points.

Question 1

In (a) the candidates who were able to correctly identify a correct test for iodide ions rarely failed to recognise the formation of the yellow precipitate. When candidates did not succeed in gaining credit it was because they proposed a test for iodine, generally with starch, less frequently using hydrocarbon solvent.

Calculation of oxidation numbers in (a)(ii) was well done, though a number thought that the oxidation number of oxygen would change in this reaction. Answers for sulphur of +2 and +4 or +5 and +7 were the most common way to miss the third mark though this did not inhibit progress in (a)(iii).

A pleasing number of candidates were able to use the oxidation numbers to justify the stoichiometry of the reaction. A few candidates simply suggested the ratio of the change in oxidation numbers was equivalent to the ratio of iodate to hydrogensulphite and hence proposed a ratio of 3 moles iodate : 1 mole hydrogensulphite. Some candidates used the acceptable method of considering electron transfer to justify the ratio though on occasion such responses missed out on credit as they confused reduction and oxidation in terms of loss and gain of electrons.

In (b), both the ability to describe the practical elements of the experiment and process the results were demonstrated skilfully by candidates. A minority of candidates proposed the use of acid/base indicators in (b)(ii). In (b)(iii), (iv) and (v) answers to calculations were clearly expressed but the most common error was the inability to scale up from a sample size of 10.0 cm^3 to 1 dm^3 in the final step.

Question 2

Most candidates found completing the Hess Cycle in (a)(i) straightforward with few examples of missing or incorrect state symbols. A few candidates attempted to multiply the whole cycle by 2 in order to use whole numbers to balance the cycle. In doing so they often failed to appreciate the effect on the data in the cycle.

Manipulation of the data in (a)(ii) and (a)(iii) proved more challenging. In (a)(iii) a minority of candidates simply combined the given data with their answer from (a)(ii).

The principles behind ‘dot and cross’ diagrams seem embedded in candidates’ understanding of key ideas. Applying the concept to determine the bond angles of a molecule is less well known. For instance in (b)(i) few errors were seen; those that did occur mainly resulted from absent lone pairs on either the oxygen, or more commonly the chlorine atom. Candidates used a variety of strategies to determine a HOCl bond angle in (b)(ii). A few simply stated the angle to be 180°, some assumed 3 atoms would give an angle of 120°, whilst many did suggest the angle was approximately 104.5°. However justifications were generally based on the idea that the angle is reduced by 2.5° per lone pair. Whilst this is sound technique to determine an approximate value for the angle it does not provide a justification. As in June 2005 often candidates talked about atoms or bonds repelling without considering the repulsion or space-filling properties of lone pairs of electrons compared with bonding pairs.

In (c) candidates seemed to be able to use Le Chatelier's principle to suggest the effect of a pressure change. Unfortunately a minority failed to recognise the number of gaseous molecules was the same on both the left and right hand side of the equation.

Question 3

In (a)(i) most candidates successfully identified the correct chloroalkane. However an appreciation of how the hydroxide ion attacks the chloroalkane was not often evident. Diagrams lacked precision with candidates' answers often showing attack of the bond rather than the carbon atom. Occasionally candidates exemplified their response with a short written description of the attack, which was helpful in the case of ambiguous diagrams. Care should be taken by candidates when showing the attack of the hydroxide ion as in some cases the attack seemed to arise from the hydrogen atom.

Most candidates who identified the reaction as elimination in (b)(i) were able to identify potassium or sodium hydroxide as a key reagent, often in ethanolic solvent. The requirement for heat and/or reflux was less well known.

Whilst in (c) the presence of hydrogen bonding was widely recognised the understanding of how the bonds form is still lacking. A disappointing number of candidates continue to show hydrogens attached to carbons taking part in hydrogen bonding or bonds between two hydrogen atoms. A number of poorly drawn displayed formula showed C-H-O bonds. Recall of the bond angle of 180° was widely known but candidates encountered major difficulties in identifying the correct position in which to place it on the diagram. Many answers drew the angle between two atoms and not two bonds.

The ability to translate a structural formula of an alkene monomer into an unsaturated polymer perplexed many candidates. Answers in (d)(i) often showed a six-carbon chain as part of the two repeating units. In addition a minority of 'unsaturated' polymers occurred. It may be helpful in this type of question for candidates to practise re-drawing the monomer as one carbon-carbon double bond with two side groups coming off each carbon before they construct their polymer.

In (d)(ii) the role of van der Waals' was recognised but many candidates considered the length of the polymer chain rather than the number of electrons when explaining their answer.

Although lots of candidates sensibly suggested that poly(propene) may be stronger than its 'natural' alternatives in (d)(iii), such answers were often accompanied by spurious justifications. A surprising number of answers suggested poly(propene) was renewable. In addition a commonly held view was that the time scale for growing natural fibres was unacceptable.

Question 4

In (a)(i) the basic ideas behind the systematic naming of isoprene were evident. However missing the finer points of detail often prevented full credit from being awarded. For instance a significant number of candidates labelled the double bonds in the 1,4 positions or failed to recognise the molecule as a diene.

The colour change associated with the reaction between bromine and alkenes was widely recognised in (a)(i) as was the reaction type and mechanism in (a)(iii). A number of candidates persist in the notion that if they do not recall the correct response to a reaction they should list as many possible reaction types and mechanisms as possible, which will often result in no credit. When adding bromine in (a)(iv) a number of candidates seemed to ignore the reference to 'excess' so did not add bromines to all four carbons in the chain.

In (b)(i) van der Waals' forces were widely recognised as the only intermolecular force present. In (b)(ii) answers often did not go for enough though. Although recognition that Q had the higher boiling point was common too often justifications did little more than state the Q had a large surface area. It was important for candidates to emphasise the notion of packing or contact between molecules to gain credit here.

Question 5

Few candidates were able to name sodium hypochlorite using Stock notation. A large number of answers used the non systematic name with the addition of (I) following 'hypochlorite' Whilst earlier questions seemed to provide evidence that candidates were comfortable with the notion of oxidation numbers this was less obvious here as candidates assumed that chlorine's oxidation number remained constant. As a result sodium(III) chlorate was a common incorrect response.

In (b) over half the candidates were able to describe a free radical, though answers still persist that portray the particle as simply an unpaired electron. Other answers that did not gain credit did not manage to emphasise the free radical's particulate nature, for example by describing it as an element or compound with an unpaired electron.

Large numbers of answers scored credit in (c) and the best responses clearly linked the alternative mechanism provided by the catalyst to the drop in activation energy, a skill that will be important at A2 level. Where candidates failed to score two marks it was generally because they took no account of the alternative mechanism.

Part (d) allowed most candidates to demonstrate the ability to find appropriate information from the passage to answer a question. A few candidates seemed determined to change the text from the passage into their own words, which is fine provided the chemical meaning of the answer is not lost, which in a small number of answers was the case.

In (e) the best answers showed a real appreciation that the accumulation of dioxins could mean they reached toxic levels in the higher levels of a food chain. A number of responses merely reworded the stem of the question and it was common to see answers that simply stated dioxins were toxic, regardless of concentration.

The summary of the passage produced some very good answers and the consensus amongst examiners was that the quality of written communication was slightly better than previously seen. The best summaries were succinct and made clear reference to the three areas in the question. On occasions candidates missed out on key points due to omission of a key word or phrase. For instance it was essential to realise that hydrogen peroxide was formed from the reaction of percarbonates or perborates with water, not from simply mixing or dissolving. Careful reading of the passage to ensure key points are made in the correct context is important. For example decomposition of hydrogen peroxide to produce free radicals had to be in the context of stain removal. Some responses implied that this was a separate, additional process occurring at the same time, but separate to stain removal. Presentation was generally clear though a number of candidates approached the question by summarising a large part of the passage then editing down their response. The resultant crossings out made such summaries difficult to follow and tended to stifle the flow of the response. The majority of answers were within the word limit.

Hints for Revision

- Practise drawing hydrogen bonds between a range of molecules and ensure you can mark the 180° angle in the correct position

- As well as recalling what is formed in organic reactions try to make sure you can describe how species such as nucleophiles can attack organic molecules.

- Ensure you can remember the different tests and observations used to identify different species in Topic 6. Read questions with care, as it is easy to confuse some species and hence suggest an incorrect test, for example iodine and iodide.

- In the summary try to ensure your sentences are short and to the point. When using your own words be careful not to amend the meaning of the original passage.

- Try drawing addition polymers starting with a variety of different monomers. Practise with the monomers shown as both displayed and structural formulae. Remember two repeating units of an addition polymer will have a four carbon central stem.

6253/01 (Internal Assessment of Practical 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 B. 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. Edexcel should be notified of amendments to a centre's marks.

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. A copy of the Summary Evaluation Proforma (SEP) is included in Appendix B to assist teachers to construct suitable candidate profiles. Centres are reminded that the Assessment Leader at 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 students 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. The Assessment Leader will not normally accept marks where coursework is not available for moderation.

6254/01

This paper provided candidates with a significant challenge. They were particularly successful with the calculations on the paper but found it difficult to express themselves clearly when trying to explain chemical phenomena or when justifying chemical techniques.

Question 1

This proved to be a difficult start to the paper.

In (a) only the best candidates were able to suggest two methods for following this reaction. The commonest correct response was to place the whole apparatus on a balance but this did not always achieve a mark because of a failure to explain that there would be a loss of mass because carbon dioxide would be given off. A surprising number of candidates thought that the disappearance of the solid calcium carbonate as it reacted would bring about a loss in mass. Some candidates wanted to measure the water or to titrate the calcium chloride with an acid or alkali or thought there was a change in colour. Dilatometry is not a good idea when a gas is involved and the number of ions present actually decreases from 4 to 3.

Part (b) revealed a wide range of misconceptions with very few candidates realising that carbon dioxide is slightly soluble in acidic solutions or that some gas might escape before the bung was attached to the flask. Many thought that at first air would go into the syringe and so should not be counted until the air was saturated with carbon dioxide or that somehow the small amount of carbon dioxide in the air would go into the syringe first.

Although most candidates were able to complete the table of results successfully hardly any knew that V_{final}–V_t was proportional to the concentration of the hydrochloric acid even though this is the first experiment in the topic. Although the scale on the graph was not the easiest most candidates successfully drew an acceptable graph but many were not so good at measuring half lives. The first point occurred at a time of 5 seconds and not at zero and this caused an incorrect first half life. The best candidates calculated half lives going from 80 to 40 to 20 and then to 10 rather than starting at 85 cm^3.

In (d) many candidates did not refer back to the equation carefully enough and did not realise that the number of particles remained the same (either 3 on each side or 5 if you considered the ionic equation). However most realised that the reaction was spontaneous and so the total entropy change would be positive.

Question 2

This proved to be more difficult than expected for the weaker candidate. Perhaps because the reactions were not put into context but were rather isolated examples from the course, explains their inability to correctly name the organic compounds although able candidates had no problems with this. The most difficult part turned out to be the type of reaction in (a) with few candidates realising that this was a neutralisation reaction. In (b) the numbering around a benzene ring proved difficult for some who thought that the iodine was on the third carbon atom rather than the fourth. In (c) ethanamide was not known by many. Amides are only a comparatively small part of the course and do not seem to be as well known as esters where there has been a considerable improvement in recent years. In (d) some candidates do not realise that the carbon atom in the COOH group was part of the carbon chain and so thought the acid was nonanoic rather than decanoic acid.

Question 3

Many candidates were successful in (a) even if they did not make use of all the pieces of information. In (iv) it was necessary to specify a carbon-carbon double bond and (v) proved the most difficult for candidates to explain clearly. Some candidates tried to draw a straight chain compound rather than a benzene ring. When given the molecular formula it is a good idea to work out how unsaturated the molecule is. In this case with 9 carbon atoms there would have to be 9 x 2 + 2 = 20 hydrogens if the molecule was to be saturated. As there are only 8 hydrogens, which are 12 short of saturation, there must be 6 double bonds or 5 plus a ring etc. With eight hydrogens short, then a benzene ring is likely and in this case one additional carbon-carbon double bond and one carbon-oxygen double bond in the aldehyde group make up the shortfall of 12 hydrogens.

The description of recrystallisation was extremely disappointing. Candidates should have carried out this procedure in the preparation of aspirin but even those who produced a reasonable procedure had little idea of the reasons for each step. Some did not seem to understand the word precipitate and started with a solution in cold water and then boiled off either the impurities or the benzoic acid and checked the purity of the acid by measuring the boiling point. Others confused recrystallisation with the method for preparing crystals in unit one and started by boiling off half of the water.

However (c) was generally very well done. The calculation was nearly always completely correct and the only disappointing feature was the number of weak candidates who did not know (nor could work out) the formula of sodium carbonate often giving it as $NaCO_3$. If candidates had read the question carefully they would have realised that the benzoic acid was a solid and the sodium carbonate in aqueous solution and so would not have put in their equation the incorrect state symbols.

Question 4

Esters are now recognised by most candidates although the naming of this chlorine-substituted one proved difficult for the average candidate. In (b) many candidates did not realise what they had to do. Many either tried to carry out the reaction as a titration or thought that they were measuring the rate of reaction rather than just measuring the equilibrium position. Those candidates who realised that they just had to carry out a titration with an alkali of known concentration usually scored full marks.

The calculation in the rest of this question was done extremely well by nearly all candidates including correctly working out the units of the equilibrium constant.

Hints for Revision

- Learn and understand the reasons behind the practical procedures in the experiments you carry out
- Read the question carefully, and more than once, as important and useful information can be found there
- Learn the names and formulae of all of the functional groups in organic chemistry
- Use the Periodic Table to remind you of the oxidation numbers of non-transition elements to check the formulae of inorganic compounds

6255/50 (Internal Assessment of Practical 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.

A copy of the record sheet is included in Appendix B. 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. A copy of the Investigation Mark Sheet is also included in Appendix B to help teachers with the marking of the investigation; this sheet is **not** a substitute for the record sheet.

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 candidates 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 candidates 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 even more popular than last year was the acid/magnesium exercise (the alternative using zinc was only occasionally used but this was generally rejected because of the slow rate of reaction.). 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 cm^3) 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 'line 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 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 analytical techniques not normally available in centres is to be encouraged if local access can be arranged. There must of course be sufficient opportunity for student 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 future more centres will utilise the Special Studies now that exemplar briefs are available for all 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 (Special Studies)

Biochemistry

This question produced many very good answers with scores in excess of 24 not uncommon.

Most candidates produced satisfactory answers to (a)(i) in terms of enthalpy or entropy changes though some lost the mark by failing to specify **total** entropy change and by giving wrong signs to entropy or enthalpy changes.
The instruction in (a)(ii) to copy and complete the equation was intended to help candidates to set out their answers. Those who did this were generally successful. The minus sign on the extreme right-hand oxygen atom was sometimes omitted and the required H^+ was often not mentioned or given as OH^-, H_2O, O_2 or various numbers of H_2. Those who ignored the instruction generally lost marks heavily. In (iii) most knew that animals get their energy by the oxidation of food many fewer knew that plants do so too, as well as getting energy from the sun via photosynthesis. Accurate spelling was required in (a)(iv), and also in (b)(iii).

The questions in (b) centred around the extraction of DNA and often attracted good marks. The function of the SDS was generally not understood. Few appreciated that it is a detergent and that the main function of a detergent is to get things which are normally hydrophobic into solution or suspension in water.

Knowledge of co-factors was rather patchy with many thinking that a co-factor is the same as a substrate. By no means all remembered to mention the appropriate enzyme as well as the co-factor.

The mode of action of penicillin was well described by many. Common faults were the assertion that penicillin **destroys** cell walls and the confusion of cell **walls**, which animal cells do not have, with cell **membranes** which all cells have. Some thought that penicillin is an enzyme inhibitor or even an enzyme.

The mode of action of organophosphorus compounds is described in detail in the text but candidate answers lacked conviction. These **are** enzyme inhibitors and the name of the enzyme, its normal function and the way it is inhibited were all required for full credit. Some answers gave detail about why only biting insects are affected. Selectivity was not an issue in this question.

Immobilisation of enzymes was evidently known about by the majority of candidates although methods were sometimes confused. Advantages were well understood.

Chemical Engineering

Those who tackle this Special Study normally produce high-grade answers in fair numbers and such was again the case this year. A few individuals seemed to answer more in hope than expectation but the general level was high.

The commonest error in the formula of cumene in (a)(i) was to put an extra hydrogen atom on the carbon atom next to the benzene ring. Most candidates answered (a)(ii) and (iii) correctly and the fact that three of the flows in (iv) were the same and the fourth was zero seemed not to surprise anyone. The calculation in (a)(v) proved to be a discriminating test for the candidates which many could not cope with in its entirety. Those who could do it usually provided neat and efficient working. The small number who did a very neat calculation based on the **input** to the reactor to get the propane flow were particularly impressive. In (vi) candidates had to combine information from the table with their knowledge of intermolecular forces though in fact one could get the answer from the latter alone. The common error was to reverse the order of cumene and the polyalkylated benzenes, possibly because the word ‘polyalkylated’ was not understood.

The flow pattern and velocity profile were correctly illustrated by most although significant numbers omitted the very important streamline flow next to the pipe walls and/or did not give a flow rate profile at all. The associated questions in (b) (ii), (iii), and (iv) presented few difficulties and were usually answered with confidence.

The question on reactor design in (c)(i) and (ii) were much less competently answered. Almost all wrote of ‘runaway reactions’ without being clear about what this actually meant and how it might happen. The neat argument in (ii) about heat generation depending on volume (d^3) whereas heat loss depends on surface area (d^2) was well expounded by some of the best candidates. Part (c)(iii) provided easy marks for the well-informed but surprising numbers thought that polymers are attacked by strong acids and alkalis or that they are far more expensive than alternative materials.

Food Science

There were some impressive scores on this question and rather fewer really weak ones.

The idea of **types** of nutrient was accepted by virtually all candidates. Most identified A as a protein, peptide or polypeptide though some thought it to be an amino acid. Quite a number identified C as a fat, triglyceride or lipid. In both these cases reasonable functions were given by most. Good candidates answered ‘vitamin’ for B. Functions tended to be too closely identified with one particular vitamin. Candidates were not, of course, expected to name the particular vitamin illustrated but, impressively, some did and were therefore given credit not only for nicotinic acid but also for specific functions.

The questions on the browning experiments were competently answered by many though marks were frequently lost by those who thought ascorbic acid is an oxidising agent or a sufficiently strong acid to affect enzyme performance. A disturbing minority attributed browning in water to the oxygen atoms which are combined with the hydrogen atoms in water molecules. Some of those who avoided this error did not make it at all clear that there is oxygen dissolved in tap water.

Marks were lost by those who omitted to mention the **rate** of browning in (b)(iii) or having correctly diagnosed the reason for the use of 1,2-dihydroxybenzene (benzene-1,2-diol) did not know that compounds similar to it are naturally found in apples.

Answers in (c) tended to lack detail. ‘Refrigeration’ and ‘cooking’ were not enough without appropriate temperatures. Many did not know the meaning of ‘mesophilic’.

Weak answers in (d) were vague and unspecific whereas the Food Science text provides much appropriate and closely argued material from which to answer the questions. In (d)(ii) it seems that substantial numbers of candidates did not know the significance of the word ‘sustainable’, which is strange because it is a word very frequently used in connection with matters of the environment. There was much made of the ash from burning forest clearance being used as fertiliser when such use is plainly not sustainable.

Some candidates seemed to be answering from supposition passing as general knowledge resulting in answers which at times verged on the patronising. By contrast there were many well-informed answers including some in which there was evidence of first-hand experience.

Materials Science

For the most part candidates coped well with this question. There were those, however, who seemed to think that this Special Study was supposed to be exclusively about metals. Consequently they put in a good performance on (a), (c) and some of (d) but found themselves at a loss when faced with questions about concrete in (b).

The questions in (a) were well answered. Interpretation of the cooling curve experiment was confident and few made mistakes in the sketch in (a)(v).

Part (b), as noted above, was quite a different matter. It was easy to spot the candidates who had read, with understanding and interest, the relevant parts of the Materials Science text. The chemistry behind the manufacture and setting of cement and concrete is not simple and is the subject of some debate so great detail was not expected. Most knew that strong heating of the ingredients was involved in (b)(i) but descriptions of the effect of heat on limestone revealed surprising ignorance of this elementary piece of chemistry with a range of gases being evolved and metallic calcium remaining, according to some. Descriptions of the effect of adding water in (b)(ii) revealed confusion between hydration and hydrolysis. Few knew about the timescale involved in the setting of concrete in (b)(iii) although descriptions of the environmentally unfriendly character of cement manufacture enabled candidates to score at least one mark.

The full four marks were frequently scored in (c) which was well understood and frequently described with much confident detail.

Inevitably there were those who muddled the colours in (d)(i) but the wet corrosion of iron was well understood in both (i) and (ii). The mistake most frequently encountered in the equation was the omission of the electrons.
The most disappointing part was (iii) where, not infrequently, candidates lost all three marks by asserting (in various ways) that copper is more reactive than iron. Those who did correctly conclude that bimetallic corrosion would occur, accelerating the rusting of the **steel,** often did not pick up the final mark for realising that the electrons lost by the iron are transferred to the oxygen.

Mineral Process Chemistry

There was only a small number of candidates for this question and there were no really outstanding scores.

Whilst candidates understood the ball mill and the spiral classifier they were not familiar with the term comminution and did not fully understand froth flotation. An understanding of the way detergents work was needed here and, as was mentioned earlier in the Biochemistry section, this probably needs to be taught rather than left to the candidates to read about.

Shaking tables were understood and were clearly explained. In (b) the chemistry of the situation was lacking in accurate detail and the calculation was illogically set out and muddled in execution.

The applications in (c) were appropriately described although in (c)(ii) candidates wandered off into catalytic converters instead of concentrating on mineral processing.

Hints for Revision

- There is a wealth of help for students on the Nuffield Re:act website. As well as updated texts for four of the Studies there are detailed study guides and sets of multiple choice questions.
- The experiments are an important part of the course. In carrying out these it is important to keep asking about the reasons for the various procedures. Make sure you know what the purpose of each experiment was and what can be concluded from it.
- Excessive reliance on A-level Biology courses is unlikely to produce high marks on either Biochemistry or Food Science. In this course these Special Studies are treated as applications of Chemistry so you must expect to have to apply chemical principles.
- Questions will be asked, to the extent of between 8 and 10 marks, on applications and technological aspects. Because you cannot reasonably be expected to know about such things if they are outside your experience, it follows that the questions will be based on the texts, limited in scope though they are. None of the texts is very long and you will probably not need to write summarising notes but you do need to read **all** the chapters.
- When doing the examination you get 45 minutes to answer 30 marks' worth of questions. This is plenty of time so do not rush the early parts of the question. Set your answer out neatly and logically and be sure to answer the question which is actually being asked, not one which you recall from a past paper.

6256/01

The paper seemed to be well received by the candidates. All questions were attempted, with very few candidates failing to complete the paper. There were a number of marks which were achieved by very few candidates as there were some parts of questions which were only completed successfully by stronger candidates. Questions requiring longer written responses showed variable quality of written communication. Weaknesses in communication skills seemed to be independent of candidates' ability in Chemistry. A particular cause for concern is the inability of some candidates to use the terms 'atom', 'molecule' and 'ion' correctly. As with last year there are two major areas in which candidates could improve their performance on this paper. First, candidates need to read the question carefully. Second for this paper in particular, candidates need to be fully familiar with their Students' Book. There were many instances where they could have used their books to verify forgotten detail and their responses showed this had not been done. Greater knowledge of where Topics are in the Students' Book would help overcome this.

Question 1

This proved an accessible question to virtually all the candidates, most gaining at least half the marks. Nearly everyone was able to make some attempt at the energy cycle in (a)(i). A common error was the omission of state symbols, particularly for the gaseous atoms and/or ions and iron sulphide, perhaps indicating a lack of detailed knowledge of the definition of lattice energy. The appropriate symbols for energy changes are not all well known, particularly the symbols for ionisation energy, and electron affinity. Candidates are advised that it is best to draw a detailed energy cycle like Figure 16.1 on page 385 in the Students' Book. Full marks could only be obtained for a Hess like triangle if the detailed energy changes and state symbols were given in the calculation. Sources of error in the calculation, were omission of first or second ionisation energy or first or second electron affinity, often replaced by multiplying one or the other value by a factor of two. In spite of the formula of iron sulphide being given in the question, a surprising number of candidates thought up there own formula, Fe_2S_3 giving the most amount of extra work! Many candidates appeared to breathe a sigh of relief at the completion of the calculation and omitted to give the answer to the requested number of significant figures. Some omitted the units. In (ii) weaker candidates simply copied Fajans' rules from the Students' Book, showing no understanding of their significance. Good candidates commented on both the charges and the relative sizes of the ions, and deduced that the iron ion would polarise the sulphide ion, giving additional covalent character to the ionic bond. In (c) most recognised hydrogen sulphide in (i), but could not relate the various experiments in iron Chemistry in Topics 1 and 19 to arrive at a test for iron(II). Despite the solubility rules in Topic 1, many thought iron(II) chloride to be insoluble in (iii).

Question 2

Only very weak candidates gave the wrong 'dot and cross' diagram for 1,2-diaminoethane in (a)(i), often omitting non-bonding electrons on nitrogen. Most candidates then ignored those non-bonding electrons in working out the NCC bond angle for the molecule giving linear structure with a 180^o bond angle. The HNC angle was better known, but the justification was often unconvincing, lacking the detailed knowledge that non-bonding pairs repel more than bonding pairs of electrons. The reaction in (b) is not well known, and the need to react both amine groups eluded all but the most able candidates. In (c), very few did not know 'bidentate' in (i). Lack of detail was evident in (ii), a **dative**, **covalent** bond occurs between the **non-bonding** electrons on the **nitrogen** atoms and the **positive** ion. Few candidates recognised there were six bonds to the positive ion and hence an octahedral shape in (iii). Most managed the equation in (iv), though some wrote it the wrong way round. In answering entropy questions like (v) precision of expression is needed. Many failed to distinguish the entropy change of the **system**. More candidates were successful in (d) with their polyamide formula than last year. Common errors concerned the numbers of carbons in the chain, and the ends of the chains – a repeatable unit was required.

Question 3

Part (a) was a place where candidates could usefully refer to their Students' Book if they had forgotten the detail, but this was rarely done. Concentrated nitric and sulphuric acids with reflux for an arene nitration, was the common response. In (b) only the better candidates were able to apply their understanding of redox reactions to this unfamiliar reaction, and recognise that reduction – addition of hydrogen and removal of oxygen was occurring. However, many were able to correctly work out the name of **C**, in (c)(i). It is important to know chemical tests for functional groups, like the test for an aryl amine in (ii).

While many reacted the phenol group with sodium hydroxide in (d)(i), the application of hydrolysis of carboxylic acid derivatives to amides was appreciated by very few. Many appreciated that phenol is too weak an acid to react with sodium carbonate solution in (ii).

Part (e)(i) was a good discriminator. Good candidates read the question and gave the parts of the molecule involved in each of the three intermolecular forces. This needed to be quite clear – 'oxygen atoms hydrogen bond to hydrogen atoms…' was insufficient without the addition '…which are bonded to oxygen or nitrogen atoms'. Many recognised that hydrocarbon chains reduce solubility in (ii), though again at this level a further justification is desirable like 'because of the Van der Waals' forces between them'.

In (f) the common error was to give the functional group rather than the bond, or to give the non-hydrogen bonded value for the absorption. Reading the question was important in (g)(i), which asked for the molecular formula of the ion – as is usual in identifying mass spectrum fragments. Charges appeared almost randomly in (i) and (ii), indicating a lack of understanding of the operation of a mass spectrometer. Part (h) could be recalled or answered from the Background Reading on aspirin in the Students' Book.

Question 4

Part (a)(i) gave an opportunity to apply practical knowledge to an unfamiliar set up. There were some interesting and potentially explosive responses. Good candidates read the question and arranged for a vacuum pump to draw air through the solution. Only very weak candidates could not balance a redox equation for oxygen and hydrogen in (ii). The mole calculations in (iii) were well done, with better candidates able to relate their results to the calculation of oxidation number with its sign. Those who had done the determination of iron in iron tablets and answered the questions in the Students' Book were able to answer (iv).

In (b)(i) errors occurred through failure to place the reduced form on the outside of the cell, omitting state symbols, and erroneous placement of phase boundaries. In (ii) there appeared to be a misreading of the Table in the Book of Data – a ruler would help here! Only better candidates could balance the equation using oxidation numbers in (iii). Application of thermodynamic data requires specific language in (iv) – the reaction goes to completion because the E_{cell} value is **more positive** than +0.6V. A justification was needed for each part as indicated in the question.

Hints for Revision

- Read the Students' Book as much as possible to become as familiar with it as possible
- Learn the names of Topics with their numbers in the Students' Book so that forgotten detail can be found quickly
- Practise reading synoptic questions, highlighting important words
- Practise drawing chiral isomers, dipeptide structures and polyamides
- For each organic functional group learn one appropriate test
- For each organic functional group learn one feature of the infra red spectrum
- Practise the calculation and interpretation of lattice energies
- Practise applying Fajans' rules
- Practise applying electrode potentials, drawing electrode potential charts and their interpretation

Appendix A – Statistics

6251/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	47	42	37	32	27
Uniform boundary mark	90	72	63	54	45	36

6252/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	47	42	37	32	28
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	43	39	35	31	27
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	59	52	46	40	34
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	35
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	52	46	40	34
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	25
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.

Appendix B

SUMMARY EVALUATION PROFORMA
SEP/UT3
CHEMISTRY (NUFFIELD) Unit 6253/01

Instructions for Completion

Sections 1-4 should be completed as appropriate during the course.

Section 5 provides an ongoing record of the assessments made during the course. The mark for an assessment should be recorded as it is completed so that the progress of each candidate's profile can be monitored. The selected profile must meet the specification requirement and each candidate must have one assessment from each of the categories **outlined in bold.** The profile must also have at least one assessment from two of the Topic areas: Inorganic, Organic and Physical. Codes for assessments devised by centres should be recorded in the correct column of the table in the space provided. **This table is NOT intended to represent the minimum number of assessments which should be made during the course.**

Centre Name **Centre No.**

Duration of Course: September 20……… to May 20………

Section 1. Presentation of Assessment Tasks

Give any **variations** from the published assessment tasks, including any Student Briefs or other documentation issued to candidates and any further relevant comments.

Section 2. Internal Moderation

Describe how internal moderation has been carried out.

Section 3. Timing

Give details of any **variations** from the normal timing of assessments, assuming the assessments are carried out during the teaching of the relevant Topic.

Section 4. Re-sit Candidates

Give details of any variations from the normal timing, presentation etc. of assessments for re-sit candidates.

Section 5

Assessment		**Design**						**Carrying Out**					**Processing**			**Total Mark**
								Measurements		**Observations**						
janic/Organic/Physical		**I**	**P**	**O**	**P**	**O**	**I**	**I**	**O**	**I**	**O**	**O**	**I**	**P**	**P**	
Published Code		**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**C1**	**C3**	**C2**	**C4**	**C5**	**P1**	**P2**	**P3**	
Centre devised code																
Date dd/mm/yy																
Candidate		**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/15**	**/60**
Name	**Number**															

Points to note:

1. The selected profile MUST include at least one assessment from two of the topics: Inorganic, Physical, Organic;
2. The Carrying Out assessment must include one observation and one measurement;
3. Where more than four assessments are made, the BEST MARK can be selected for each category provided points 1 and 2 have been met;
4. Teachers are permitted to use the same experiment for the assessment of both Carrying Out and Processing Results, eg C1 and P1. However, where these assessments take place over more than one session, the results for the Carrying Out assessment must be kept secure by the teacher until required for the Processing assessment.

Record sheet AS Chemistry (Nuffield) Unit Test 6253/01

Centre number: ....**Centre name**:...

Student number: ....**Student name**:....................................**Form and/or set**:..............

Duration of course: September 20. . . . . . . .to May 20 . . . .

For Re-sit Students Only: Former centre number .... Former student number ....

Type of assessment	**Ability**	**Title of exercise**	**Date of assessment**	**Mark**
1 Practical Skills	Designing an experiment			**/15**
	Carrying out an experiment (1)			**/15**
	Carrying out an experiment (2)			**/15**
	Processing results of an experiment			**/15**
For office use only **MODERATED MARK** **/60**				**TOTAL** **/60**

Declaration of Authentication:

I declare that the work submitted for assessment has been carried out without assistance other than that which is acceptable under the scheme of assessment.

Signed (**candidate**) ....

Date ....

Signed (**teacher**) ....

Name of teacher ....

Date ....

Record sheet A2 Chemistry (Nuffield) - Unit Test 6255/50

Centre number: ………………**Centre name**:…………………………………………………………..

Student number: ………………**Student name**:……………………….**Form and/or set**:………….

Duration of course: September 20. . . . . . . .to May 20 . . . .

For Re-sit Students Only: Former centre number…………Former student number…………….

Type of assessment	Title of exercise	Date of assessment	Mark
1 Conducting a complete investigation			/30
2 General Practical Competence	N/A	N/A	/8
For office use only **MODERATED MARK** /38			**TOTAL** **/38**

Declaration of Authentication:

I declare that the work submitted for assessment has been carried out without assistance other than that which is acceptable under the scheme of assessment.

Signed (**candidate**) …………………………………………………..

Date …………………

Signed (**teacher**) …………………………………………………..

Name of teacher …………………………………………………..

Date …………………

GCE Chemistry (Nuffield) Unit 5 - 6255/50 Investigation Mark Sheet (IMS)

CENTRE NAME	**CENTRE NO.**
CANDIDATE NAME	**CANDIDATE NUMBER**

ASPECT: PLANNING	**RANGE**			**COMMENTS**
	0-3	**4-7**	**8-10**	
• Identifies problem				
• Relates knowledge and understanding				
• Proposes procedure				
• Uses sources				
• Uses trials				
• Selects apparatus, techniques and reagents				
• Justifies procedures				
• Safety and risk assessment				

Mark /10

ASPECT: IMPLEMENTING	**RANGE**			**COMMENTS**
	0-3	**4-7**	**8-10**	
• Manipulative skills				
• Meaningful observation and data				
• Presentation of results				
• Repeatable and accurate results				

Mark /10

ASPECT: CONCLUDING AND EVALUATING	**RANGE**			**COMMENTS**
	0-3	**4-7**	**8-10**	
• Manipulates data				
• Sources of error				
• Conclusions and validity				
• Theoretical justification				
• Evaluation of techniques				

MARK /10

The bullet points should NOT be regarded as being equally weighted.
A student's report should be marked by consideration of the three aspects, each marked out of 10. Assess the work against each bullet point ticking the mark range for the standard achieved (page 58 of the Specification). The pattern of ticks will help to assess the final total out of 10 for each aspect. The overall total for the investigation is reported as a mark out of 30. [*Remember to add on the GPC mark (out of 8) to get the candidate's final total mark.*]

TOTAL /30

Appendix C – online marking (ePEN)

Most of the chemistry (Nuffield) papers are now (or shortly will be) 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.

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