Examiners' Report Summer 2008

GCE

GCE Chemistry Nuffield (8086/9086)

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General

Examiners felt that candidates were well prepared for questions involving recall of factual information and simple calculations. Descriptions and explanations of familiar phenomenon were also sound. However when faced with an unfamiliar context, the quality of response diminished significantly both in terms of chemical content and quality of written communication. Technical terms, used correctly in other contexts, were often confused, and vague language sometimes made it difficult to award credit. The quality of diagrams was extremely variable and the consensus from the examiners was that this is an under developed skill.

Section A

Question 1

The majority of candidates could calculate the number of moles of iron(III) sulphate. In (b) most candidates were able to describe the reaction as reflux. Candidates were less successful when attempting to justify the reaction in terms of electron transfer, with a particular lack of precision when describing which iron particle had gained an electron.

Question 2

This question was generally well answered, though a minority of candidates thought CH_3CH_2CHO was an alcohol. Interestingly this did not seem to hinder them in giving an accurate description of what they would see when CH_3CH_2CHO was heated with Benedict's solution! The most common way to lose a mark in this section was a failure to recognise that a precipitate would form.

Question 3

Most candidates were able to work out the number of neutrons in (a)(i) and the calculation in (a) (ii) was also well done. Most working was clearly shown and relatively few candidates ignored the requirement to quote their answer to four significant figures. A common error amongst the incorrect responses was to divide by four somewhere in the working, most commonly by finding the average of the four atomic masses but frustratingly in some cases, by dividing the correct answer by four. The key to (b) seemed to be recognition by the candidate that the species involved was a Cl_2^+ ion. Those who did gave some excellent answers, explaining concisely why they would expect to see three peaks. However they were in the clear minority with most candidates assuming two peaks would be seen as 'chlorine has two isotopes'.

Question 4

Candidates often identified reaction 1 correctly in (a) (i) and tests for the gaseous products in (a) (ii) often scored credit. A lack of clarity in some responses occasionally prevented the award of the oxygen mark with candidates describing their spill / splint as 'burnt out' or 'previously lit' without any indication that it was glowing or very recently extinguished. Nitrogen dioxide was commonly recognised by its brown colour. A minority of candidates referred to NO_2 as 'nitrogen' or 'nitrate' gas. In (a) (iii) a high level of skill was shown by many candidates. Although the question was not sub-divided into parts, candidates' working out often showed a clear structure to their work, enabling examiners to see clearly what they were trying to achieve. More able candidates often scored three marks. Common errors were to incorrectly calculate M_r for $MgNO_3$(s) or propose incorrect units for the volume, either by confusing cm^3 and dm^3 or by suggesting cm^3 mol^{-1}.

Ionic equations, such as the one in (b) (i), continue to be particularly challenging. Often there was evidence of candidates attempting to construct the equation from first principles. However this rarely led to a correct answer as candidates failed to spot the spectator ions or gave incorrect numbers of each ion. The best answers simply worked back from the precipitate, splitting it into its constituent ions. The full spectrum of colours was suggested in (b) (ii) though the majority did suggest white. A few responses seemed to be describing the solution, with references to colourless, and a small number hedged their bets by referring to white in combination with another colour, which was not awarded credit. Interestingly more candidates were able to process a calculation to determine a number of moles in solution in (a) than write the correct formula for magnesium chloride in (c) (i). A small number failed to read the question correctly and gave the name instead.

Lots of candidates took heed of the feedback given in earlier sessions and did learn the stages involved in the preparation of dry crystals from a salt solution in (c) (ii). However the formulaic approach adopted by some candidates resulted in a number or responses that were little more than a series of bullet points. Such answers did not always show understanding of the process. When candidates failed to score full credit it was often because they failed to recognise the need to pick out the crystals or decant off/filter any remaining solution before the drying stage. Candidates also need to take care with the description of the first stage of the process as a small number of responses made it difficult to judge whether or not candidates actually planned to remove all the water at this point. Some weaker candidates seemed to adopt a 'pick and mix' approach, bringing in techniques from all areas of the course. As a result use of techniques such as distillation or use of anhydrous, often water soluble, salts as drying agents were inappropriately suggested.

Question 5

Some candidates seemed to find it difficult to interpret the diagrams of the alcohols in (a) and hence failed to recognise which two were identical. Those who spotted that D and F were the same, did not always score additional credit for the name. Errors such as missing the prefix 'di' or only having one '2' in the name were frequent. However responses to (a) (ii) were often excellent with candidates able to recognise and describe the nature of a tertiary alcohol. Many good answers to (a) (ii) were also seen and descriptions of isotopes, though evident, were rare. Part (b) was well answered by many. A few candidates seemed to think that 'type of reaction' in (b) (ii) referred to a technique so suggested answers such as 'reflux'.

The quality of diagrams in (c) (ii) was extremely variable and examiners felt, with a few notable exceptions, there was little evidence of improvement from previous sessions. Whilst examiners accept that under examination conditions a 'perfect' diagram may not be attainable they do expect diagrams to be chemically and technically sound. Although the majority of candidates made an attempt to draw a distillation set-up, diagrams containing unrecognisable pieces of glassware or that simply would not work often lost marks. Common examples included diagrams with no or few joints between individual pieces of glassware, completely sealed apparatus, condensers drawn in such a way that the water flow enters the central tube alongside the condensed products and systems open at the side-arm so that when heated reactants/products simply escape.

Question 6

A significant minority of candidates gave only a description of the trend in (a) (i). When explaining the pattern, most recognised the importance of the increasing number of protons across the period. Although many also described the increasing number of electrons as well, few considered the effect this would have on the trend and hence the second mark point was achieved far less frequently. In (a) (ii) the sketched line was often shown, as one would expect, above the line for Period 2. Very few candidates actually named this phenomenon as periodicity and simply repeated their answer from (a) (i). However many candidates were able to justify differences with reference to the increased number of electron shells and the subsequent effect this would have on shielding and the nuclear force. Some answers simply talked about an 'increased number of electrons' which, on its own, did not score. Poor quality of written communication sometimes hindered the ability to award credit. For example a small number of responses talked about Period 3 having 'more outer electron shells' and generally failed to score this point.

Candidates had few problems in identifying the bonding as metallic in (b) (i) but there was little evidence to suggest that they understood the forces holding the metal structure together in (b) (ii). Hence few were able to explain why lithium's melting point was higher. Some answers seemed to be discussing ionisation as candidates talked about lithium's reluctance to lose outer shell electrons. Other candidates, despite clear labelling in the question, ignored the fact that the key force was between ions and delocalised electrons and references to atoms and even molecules were commonplace.

In (c) (i) the majority scored 2 marks. However despite the fact that covalent 'dot and cross' diagrams are not part of the specification for unit 1, a number of candidates drew incorrect representations of lithium chloride based on a covalent model. In (c) (ii) many accurate descriptions of electron transfers leading to flame colours were seen. A small number lost credit by referring to ions or atoms being promoted to higher levels and then falling back to the ground state. Very few candidates failed to suggest a metal that would also produce a red flame colour in (c) (iii).

Question 7

For many candidates this was the most challenging question in section B. Although most candidates recognised the need to put in symbols for elements in (a) (i), a reasonably high proportion failed to score both marks. Sulphur was commonly seen as diatomic and also in the gaseous state. Balancing the equation was also problematic for many. A number thought two sulphur atoms were required and a minority also proposed '$\frac{1}{2}O_2$'. The definitions in (a) (ii) were generally poor. Many candidates talked in very general terms about 'energy when bonds break and form' and others talked about the 'energy required when a compound forms', failing to recognise both the idea of an energy change and the need to quantify the change in terms of per mole. Many however did correctly suggest the need to form 'from the elements' though a few lost the mark by stating you should always start from 'one mole of the elements'. 'Under standard conditions' was often suggested but additional detail of the precise conditions was needed to score credit. Having praised candidates for clear working out in 4(a) (iii) it was less evident here. A number of candidates did not seem able to apply Hess's Law and so did not receive credit.

In (b) (ii) some candidates failed to specify a named indicator in the test for an acid whilst others didn't appreciate the need for water, which could have been implied simply from the use of the term 'damp'. A small number, perhaps recalling hydrogen sulphide from unit 2, suggested the use of lead ethanoate paper. The majority of candidates used the phrase 'partially dissociates' in b(ii) which on its own was not worth credit. In order to score here candidates need to show they realise that *very few* of the acid molecules dissociate.

Hints for revision

- Practise drawing, interpreting and naming formulae of organic molecules drawn in a variety of different ways other than with the longest chain drawn horizontally across the page.

- Try to make sure you understand the principles behind key definitions rather than trying to learn them off by heart. This way, if you forget a bit of detail you stand a better chance of working it out in the exam.

- When describing or explaining processes at a particulate level think carefully about the terms you use to describe the particles. When you use words like atom, ion or molecule be sure that particle is genuinely involved.

- Practise drawing diagrams of equipment to carry out reactions. Check your diagram against a text book and review your version, asking yourself whether your diagram would actually work as you've drawn it.

- Make sure you can fully explain as well as describe trends across periods. Practise your explanations on your friends. If they can understand you there is a good chance you are on the right lines.

- When working out stages to calculations, briefly jot down the quantity you are attempting to calculate as well as the sum you are doing. This will help you keep track in a multi stage calculation.

6252/01

General

The general impression given by the performance of candidates on this paper was mixed. There were some candidates who had obviously learned the work thoroughly. In contrast there were many papers which suggested that candidates had not adequately prepared themselves for this examination. The other common problem was a candidate's failure to read the question.

Question 1

This question combined elements of Topic 6, The Halogens, with Topic 10 The Halogenoalkanes. Both topics need to be learned carefully. The problem for many candidates seemed to be that the Topic 6 work had been forgotten, and the Topic 10 work had not been learned sufficiently accurately. This was demonstrated in (a)(i) where only half the candidates recognised the yellow precipitate was silver iodide. The equation in (ii) proved equally difficult, even though a transferred error from the first part was allowed. Common errors were in state symbols or failure to learn the charges on the silver or iodide ion. The equation in part (iii) was completed by about half the candidates. Weaker candidates did not know the organic product was an alcohol. Some gave the elements iodine or hydrogen as products.

Classification of the reaction type and reagent type was, as usual, a good discriminator in (b). The common error was to give 'displacement' in (i). There was evidence of insecure knowledge with candidates giving 'nucleophilic substitution' in (i) and 'acid-base' in (ii). It is always an error to give two answers in the hope that one is correct. Many candidates gave a partial explanation like 'because it has a lone pair'. Part (c)(i) should have been straightforward, but responses suggest many candidates had not done this experiment. Many heated the reactants in a flask, while those drawing the correct apparatus, omitted to label the reactants, or included aluminium oxide. There were more 'poor' diagrams with tubes going through the side of troughs than usual. Very few correctly deduced a tertiary compound in (ii), again making examiners wonder whether this experiment had been done. 1-iodomethylpropane was the most popular near miss answer, missing the point that the key is the weakness of the carbon-halogen bond or the stability of the tertiary carbocation in (d).

As usual candidates found difficulty in drawing addition polymer structures in (e)(i). In (ii), as in January, the common omission was the word 'gaseous' in the reaction should go towards the side with fewest gaseous molecules. Catalysis was better explained, though many gave one or the other of the two correct responses, the catalyst provides an alternate route without mentioning lowering of the activation energy or vice versa.

Question 2

This was generally answered much better. The three intermolecular forces were usually correctly named in (a)(i), (b)(ii) and (c)(i). Only weak candidates did not relate the strength of van der Waals' forces to the number of electrons in (a)(ii). In (b)(ii) weaker candidates omitted the non-bonding electrons on the oxygen, or gave the wrong number of carbon atoms. Similarly only weaker candidates formed the hydrogen bond with carbon-hydrogen hydrogen atoms in (b)(iii), and had not learned the relevant bond angles. Once again, answers suggested candidates were unfamiliar with the experiment in (a)(iv). Some failed to read the question and seeing enthalpy change and an alcohol described an experiment to find the enthalpy change of combustion rather than vaporisation. Most candidates realised how to do (v), though once again, a significant number 'hedged their bets' giving two or more answers. While demanding (c)(ii) was successfully answered by the better candidates. The key was to give the detail of which atoms in each molecule would be involved in the new intermolecular bond in the mixture. Cracking was usually remembered in (d)(i). Once again type and mechanism were not well known in (ii).

Question 3

Most better candidates correctly gave boiling potassium hydroxide solution in (a)(i). Weaker candidates could not recall the experiment and wanted to reflux or add alcohol. Oxidation numbers were, as usual, correctly calculated by all but the weakest candidates. Signs must be included, of course. Writing the balanced equation for this reaction was a good discriminator for Grade A candidates. It is a matter of learning and practising applying the rules highlighted on page 121 of the Students' Book. Part (iv) was not done as well as in the past, often failing to answer the question 'an element oxidises and reduces itself' rather than 'iodine oxidises…' due to a failure to read the question 'why **this** is classified as a disproportionation reaction.' Though many candidates had done the experiment in (c) as an assessment, the detail had been forgotten, and it was answered less well than on previous occasions. There were many weak responses in (i) like 'sulphuric acid and sodium hydroxide'. Candidates needed to know 'thiosulphate' in (ii). Many gave acid-base indicators in (iii).

Question 4

The structure of a less familiar molecule with a triple bond was done well by better candidates. The common error was to show a lack of understanding of bond angles, giving 180^o, but drawing hydrogens at obtuse or right angles. Parts (b) to (e) tested comprehension of the passage. Better candidates did well. The key is to answer each question as fully as possible, for example giving all three contaminants in (b), or ethyne reacts more slowly than ethene in (d). Part (c) required careful reading to spot that the other process is less efficient. Part (e) was similar, where many gave reactions from the passage which were in the paragraph beginning 'Many of the reactions of ethyne are similar to the reactions of ethyne' rather than from the following paragraph. The common mistake in (f)(i) was to use eth**a**ne and bromine. Part (f)(ii) was a challenge to candidates to apply their practical experience in which very few were successful. The usual problems were to fail to have a method of adding drops and a method of getting the gas out of the apparatus.

The summary was generally well done, though there were significant numbers of candidates who deleted key words from key points, losing the credit. Marks were most frequently lost through the omission of the following words or phrases from the key points: KP1- the temperature; KP2 - collection in a gas holder; KP3 - 'cold' water; KP4 – only two of purified, dried and compressed; KP5 – either temperature or low relative molecular mass; KP6 – including ethyne; KP7 – separation; KP8 – the solvent.

The common causes of loss of QWC marks were writing in note form, lack of verbs in sentences, lack of articles and poor structure. Candidates counting in excess of 100 words are strongly advised to reduce their word total to 100, rather than hope that their count of, say, 105 is correct. They often miscounted by one or two words and were penalised in accordance with the mark scheme. There was no evidence of shortage of time for the paper.

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 a few problems. 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.

The majority of the marking was very 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 was particularly helpful for moderation. 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. A detail of the raw marks and indeed the candidates' actual work in all of the assessed 'carrying out' and the 'processing' assessments was helpful when considering a profile as a whole.

In most cases, there was clear evidence of thorough and accurate procedures being adopted with regard to internal moderation. With a small number of exceptions all, the profiles covered the correct specification descriptors with the exercises being drawn mostly from the exemplar booklet. Where exemplar material was used, the agreed mark schemes were applied accurately and fairly in the vast majority of cases.

C2 continued to present some difficulties in both marking and moderating and there was still a tendency to allow a measure of imprecision here and there. There were very few 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.

The most problematic areas continued 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. A measure of leniency of interpretation has always been appropriate here with care being exercised to avoid the award of the maximum marks for trivial comments. Comments which dealt with 'human errors' (e.g. the inability to read a pipette or burette or losing some of a sample) should not have been rewarded. Correct comments should have focused on procedural and measurement errors. Additionally the responses to question 10 in P1 were often liberally treated. The response here required a clear statement that 6 moles of H^+ are required for each mole of iodate.

Teachers should 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

This paper proved accessible to the average candidate whilst providing some challenging questions for the most able. The mathematical ability of the candidates remains pleasing but most could improve their marks if they took more care over using the correct terminology when offering explanations or describing experiments when words such as element, ion, atom, molecule and compound seem interchangeable.

Question 1

Part (a) proved surprisingly challenging. Although there were at least 6 possible methods to choose from, many chose the unacceptable dilatometry which is unlikely to work when the reactants and products are in aqueous solution rather than present as liquids. The identification of which reactant or product was being measured also presented problems for many. Titration with sodium thiosulphate was often thought to identify iodide ions rather than iodine molecules and the colour of iodine was thought to be blue black and /or iodide ions were coloured pale yellow. To measure the ions produced, conductivity and not electrolysis was required.

Part (b) also proved very difficult for most candidates. Most failed to appreciate the significance of the stem which stated that the reaction was extremely slow at room temperature in the absence of hydrogen ions. The intention was that this would stop candidates just quenching the reaction by cooling further in ice. However, as this was such a common response, one mark was given if ice was mentioned rather than cold water and the candidate stated that this would reduce the rate of reaction. Of the minority that realised removal of hydrogen ions was needed, only a few suggested adding sodium carbonate or sodium hydrogencarbonate with the common answer being add an alkali or sodium hydroxide. Candidates should be aware that sodium hydroxide reacts with iodine and in the new specification will be required to know the iodoform reaction. It is not sufficient just to carry out the experiments in the Students' Book; it is essential that the steps in the method are fully understood.

Parts (c)(i) and (ii) were very well answered with candidates being able to deduce the reaction was first order with respect to propanone even though the increase in concentration was not a whole number and zero order with respect to iodine.

The rate equation in part (iii) was generally correct although some candidates missed out the rate constant. However, a significant minority did not realise that the species in the rate equation are the same as the species in the rate-determining step and included iodine.

Part (v) proved extremely difficult. Even candidates who had correctly identified the species in the rate-determining step in the earlier parts did not put these on the left-hand side of the equation. Instead iodine molecules appeared on the left and hydrogen ions on the right. In all mechanisms candidates need to realise that opposite charges attract. With this in mind candidates should have been able to predict that the hydrogen ions would be attracted to the negative oxygen in the propanone molecule. Candidates who managed to get this far often lost a mark by failing to put a + sign on their product species and so did not give a fully balanced equation.

Question 2

Most candidates were able to make some deductions about the structure of Q although only the very able could use all the information provided. Part (a)(i) proved particularly difficult. Very few realised the significance of the number of hydrogen atoms increasing from 10 to 14 when the substance became saturated and failed to state that this meant Q had two double bonds.

In (ii) a significant minority thought that failure to react with sodium meant that Q could not be an acid (although with only one oxygen atom a carboxylic acid was already not possible) rather than that Q could not contain an OH group.

In part (iii) the reaction with 1 mole of bromine molecules meant that Q could only contain **one** C=C and the one was often missing.

In (iv) and (v) were very well answered with most candidates knowing the significance of both Brady's reagent and Benedict's solution. In part (vi) candidates found it very difficult to explain 'trans' in words, with the better candidates drawing a diagram to help explain their answer.

Some candidates in (vi) were able to give the correct formula for Q even when they had made several errors in their earlier deductions and for these it was surprising that they did not go back to correct their earlier mistakes. Others were unable to incorporate all of the information into one correct formula. It was not uncommon for cis to be drawn even when trans had been explained in part (vi). Another problem was to put the two functional groups next to one another resulting in C=C=O or with the two groups at either end of the molecule. Another surprise was the drawing of a ketone when an aldehyde had been identified in (v).

In part (b)(i) two reducing agents were required. Nickel and hydrogen were known by most but often the oxidising acidified potassium dichromate was suggested rather than lithium tetrahydridoaluminate as the other one. This reagent is used in ether and although this did not have to be stated, the presence of water resulted in this mark being lost by some. The functional group present now is an alcohol and it is disappointing to report that many quoted hydroxyl, hydroxy (allowed) or hydroxide (not allowed).

Question 3

In part (a), candidates showed that they have a very good understanding of entropy. The only common error occurred in part (iii) with some candidates stating that there were more products than reactants rather than making it clear that the number of moles (or molecules) increased from one in the reactants to two in the products.

Most candidates can correctly calculate the entropy of the surroundings although there were a few who confused joules with kilojoules in part (b). This continued into (c)(i) with these candidates often adding joules to kilojoules. Part (c)(ii) was disappointing.

The course makes it very clear that if the total entropy change is more negative than -200 J mol^{-1} K^{-1} then the reaction does not take place at that temperature. Therefore, as in this calculation the value is very close to -200, candidates were expected to state either that the reaction would not occur or that the equilibrium would be well over to the left. Most just said that it would be on the left and this was not sufficient to gain this mark.

In (d) (i) most candidates could give the correct expression for K_p with only a handful of candidates getting the equation upside down. Calculating the number of moles at the start of the phosphorus(v) chloride also presented few problems but calculating the number of moles at equilibrium proved more problematical with many candidates dividing by two to give 0.025 instead of 0.05. This shows a lack of understanding of balanced equations when 1 mole of reactants can give 2 moles of products so in this case 0.05 moles of phosphorus(v) chloride can produce 0.05 moles of both phosphorus(III) chloride and chlorine. As transferred errors are allowed, these candidates only lost one mark if they were able to complete the rest of the table and calculate $K_{p.}$ Part (iv) proved challenging for the average candidate who often thought that if you halved the amount of reactant then K_p would also halve and did not realise that only a change in temperature would change the value of $K_{p.}$

Question 4

Good candidates had no difficulties with this question. In (a)(i) the sulphur trioxide or fuming was missed out by some candidates and rather surprisingly sodium was added instead of sodium hydroxide to obtain the salt although this was allowed. Most realised that the first step was substitution although neutralisation for step 2 proved to be the most difficult part of this question.

In (b)(i) most knew Friedel-Crafts although the spelling of these names was interesting. In part (ii) the question did ask for the molecular formula but in the end it was decided to allow the names, as 1-chlorododecane was thought to be at least as difficult as $C_{12}H_{25}Cl$. Arenes are known to be used in dyes, drugs and detergents by most candidates but they seem unable to recognise the likely formulae of each.

Question 5

The expression for K_a in part (a)(i) often included the concentration of water even though it has a different state symbol but a transferred error allowed candidates to score the second mark if they stated that this expression had no units.

In part (b) most candidates knew what a buffer solution was but many did not get the second mark by failing to assert that the pH doesn't change on the addition of **small** amounts of acid or alkali.

Most candidates knew in part (c) that a base is a proton acceptor but found it difficult to apply this to the equation given.

In part (d) the calculation was generally well done and most realised that the decrease in carbon dioxide at the end of the race meant that the first hypothesis couldn't be the correct explanation. Those that used their knowledge from Biology often failed to secure both marks because they did not relate their answer to the information in the table.

Hints for Candidates

- Read your answers through before moving on to the next question to check that you have used the correct term to describe the species involved (ie atom or molecule or ion etc)

- In all mechanisms remember that opposite charges attract

- When adding numbers make sure that they are in the same units (eg J cannot be added to kJ)

- When asked to comment on the position of equilibrium remember that if the total entropy change is greater than +200 the reaction goes to completion and that if it is between 0 and +200 then products predominate. The reverse is true for negative numbers when reactants should be discussed.

- In equilibrium expressions the species appearing in the expression must all have the same state symbol

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 continue to show an improving trend.

Nevertheless, a very small number of problems continue to occur falling 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 students should be encouraged to think clearly about what they really need to do.

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, 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 students who do find this quite challenging and it might be appropriate therefore for the teacher to give some assistance to allow the student 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 student 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^+

If anything even more popular than 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 student to obtain repeat results, something, which some students 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 second year 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 ‘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 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 remaining year 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

General

In the introduction to the Principal Examiner Feedback last year, a plea was made for students to 'think like chemists' when doing the Special Studies. This year's report refers, in a number of places, to ways in which this advice has or has not been heeded. It is also worth putting on record that in the preparation of the question paper a great deal of thought is given, not only by the writer but also by a small army of other examiners, assessors and scrutineers, to the wording of the questions. This is done partly to try to prevent candidates from going off in unprofitable directions in their answers. For this effort to bear fruit, candidates must read the questions carefully, try to accept the hints given and use the information available.

There seemed to be even more cases than usual of candidates being entered for one Special Study but answering the question on another. Whilst it would be difficult, and probably unjust, to prevent individual candidates exercising their judgement about which question to answer, it causes great confusion when whole centres make an incorrect entry. Each Special Study has a separate entry code (see Edexcel's Information Manual), in particular 5B is **not** the code for **all** the Special Studies.

Question 1 Biochemistry

In putting together a question on the Biochemistry Special Study, one is aware not only that the subject is rapidly developing and aspects of it feature almost daily in the media but also that the candidates who attempt to answer it fall into two main categories. There are those for whom biochemistry is part of their Biology course and there are those who do not do Biology but have chosen to do this Special Study (or had it chosen for them) as a mind-broadening experience. Inevitably some parts of questions are going to be easier for the former group than for the latter but such parts cannot be omitted because to do so would be to do an injustice to the subject itself. What the two groups have in common is that they both have a background of chemistry. The advice given in last year's report to 'think like a chemist' is therefore particularly pertinent.

Most candidates were off to a good start with (a) (i) but many lost a mark in (ii) by not indicating clearly why leucine cannot be synthesised. The key to success on this part and in (iii) was to use the flow chart as the question required. The name and formula for glycerol were correctly given by many, a common error being to have too many hydrogen atoms on the middle carbon atom.

The equation in (b) (i), as was intended, gave perceptive candidates some clues about how to answer (ii); all the necessary information was there in the question and there was little excuse for including curious ionic products as some did. Good and careful candidates got all four of the marks in (ii), common errors being to start with elaborate accounts of possible effects of alkali on urease and to ignore the production of ammonia and its alkaline nature altogether. For some reason a significant minority thought the question was about the effect of temperature.

To get the first mark in (b)(iii) it was necessary not only to state that the increase of temperature brought about increase of rate but to make it clear that this only applied 'at first' or 'up to 50°C' or some such limit-setting remark. Unfortunately some did not appreciate the significance of the 60°C graph and denied themselves the third and fourth marks. Parts (b)(ii) and (iii) were answered in a rather off-hand manner by many but there is a connection between the two. It is *because* the graphs did not start from zero conductivity (as they would have done if timing were started at the moment of mixing) that you cannot get a meaningful rate by simply reading a conductivity value and dividing it by the corresponding x-axis time. To get the mark safely and unambiguously the answer 'measure the gradient' (or something which means this) was obligatory. Perceptive candidates realised that the ions in copper(II) sulphate would confuse the conductivity situation. 'Copper ions would inhibit the enzyme' was not accepted as an answer because this, presumably, is what the proposed experiment would have sought to investigate.

Part (vi) revealed some surprising misconceptions. Some thought that a peptide *is* a bond rather than being a compound formed from amino acids *joined by a bond*. Many more insisted that irreversibility was a characteristic of allosteric inhibition and very few indeed indicated that the effect of such inhibition cannot be reversed *by increasing the substrate concentration.* Whereas the majority were happy with the meanings of 'progressive' and 'genetic' and identified a dilemma appropriately, many thought that a mutation can result from the *addition* of a base and substantial numbers discussed omitted and substituted amino acids, genes or codons. Success in this question, as ever in examinations, is to read the question carefully.

Question 2 Chemical Engineering

Students attempting this Special Study tend to be enthusiasts with a feeling for mathematical and conceptual precision. Although few students begin this study with prior knowledge, the standard reached is often commendably high. Most answers correctly defined reflux ratio but a much smaller proportion realised that the insulation serves to establish a suitable temperature gradient. Most knew that the column packing had something to do with liquid and vapour but did not always specify the need for equilibrium between the two.

There were many good answers to (a) (iv), not easy to describe in the absence of an actual example. The commonest error was in the requirement in the question to determine the *liquid* composition. Whilst most answers correctly stated the purpose of the window at E, a smaller proportion gained the mark for the purpose of the reflux condenser in returning mixture *to the column*. A disturbing minority seemed to infer that a reaction was going on and made reference to unreacted starting materials, when doing this reflux ratio experiment it is common practice to refer to 'distillate quality' but in an examination answer it is necessary to be clearer about what this actually means when answering question such as (a)(vi).

The calculations in (b) were generally done with panache and the associated questions, even the tricky sketch graphs in (b)(vii) were often negotiated successfully. The units of heat transfer coefficient sometimes omitted hr^{-1} and candidates need to be aware that surface area is not a component factor in the heat transfer coefficient; the equation given should have made it clear that area is separately allowed for.

The first three parts of (c) were satisfactorily answered but 'plug flow' was less familiar ground, possibly because the tubular reactor experiment uses a modified version where the tube is divided into sections separated by baffles. The lack of 'back mixing' is the key point here. Whereas a reasonable number of candidates had some understanding of the relationship between tubular reactors and batch reactors, fewer could explain it clearly.

Part (d), as well as addressing the Specification (Skills, (b) (i)), provided opportunities to reflect on the way chemical engineers work. The result made interesting reading with some nominating subject areas outside of those in the mark scheme which were acceptable if a good case was made.

Question 3 Food Science

Most candidates were off to a good start here, gaining credit on (a) (i) and (ii). Part (iii) yielded some surprises with a substantial minority asserting that vegetable oils have saturated molecules. The name and formula for glycerol were correctly given by many, a common error being to have too many hydrogen atoms on the middle carbon atom. Most knew that 'protein' was an appropriate answer to (v) but many could not use their experience of food storage to identify sodium metabisulphite as a preservative; 'flavour-enhancer' and 'source of essential sodium' were popular amongst the answers not accepted.

Predictably, 4.0 was the most frequently encountered wrong answer to (b)(i) but some candidates indulged in long calculations instead of using simple proportion. In (b)(ii) there was confusion between the use of quantitative Benedict's solution and the normal test for reducing sugars. To gain the mark in (b)(iii) it was necessary to state the *immediacy* of the effect of glucose intake but most knew the significance of 'aerobic'.

The equations in (b)(v) and (vi) were much better written than they were last time they were asked for — there was much less confusion between the two than formerly but elementary errors, particularly in balancing, still occurred. The role of ascorbic acid as a flour improver was rather better understood than on former occasions but its use as acid or antioxidant still featured amongst the inappropriate answers.

In (c), however, the nutrient significance of vitamin C was important and its degradation with time was the point of the question in (i). Some thought that the opposite of 'fresh' inevitably implied 'cooked' or 'processed'. A range of possible sensible answers was accepted in both (c) (ii) and (iii) but the significance of the expression 'social changes', i.e. changes in society, was often ignored. Whilst one could accept that the late 20th century saw a vast increase in the population of towns and cities and that this social change was relevant, the mention of the Industrial Revolution was bizarre in this context. It really is important to read the question.

It was also surprising to read that locally produced food might be deficient in vitamins or otherwise of inferior quality. Perceptive candidates (though all too few) stood back from the subject in (c)(iv) and 'thought like chemists' realising that 'types of chemical reaction' invites answers such as 'hydrolysis' and 'oxidation' rather than 'enzymic' or 'bacterial'. Last year's advice has not yet wholly found its mark. Part (c)(v) was a lifesaver for some with most getting at least 2 of the 3 marks available though some tried to get away with, effectively, giving the same requirement twice.

Question 4 Materials Science

Performance on this question was very variable. There were few errors in (a)(i) and most got the general idea in (ii) though a frequent error was to assume that the two cubic unit cells had the same dimensions.

The coordination number and corner fraction were often correctly given. In (a)(v) answers showed a preoccupation with rate of cooling which is not always in itself a good guide to crystal type. The best answers referred to the existence and steepness of the temperature gradient between the outside and the inside of the cooling sample. Surprisingly, many answers demonstrated vagueness about the nature of carbon-fibre composites, some suggesting an analogy with pre-stressed concrete. Many did not mention the polymer matrix at all. Tensile and compressive strength were well understood though, despite the wording of the question, some answers concentrated on the effect on the pole when in contact with the ground.

The intention in (c) was to give a strong hint about how to answer (ii) but only a few answers accepted the hint and gave a contrast between the situation in the diagram and the way electrode potentials are derived. The answers to (a)(i), (iii) and (iv) distinguished those who understood corrosion experiments from those who did not. 'Life-cycle analysis' is a term applied to manufactured articles, not to individual materials. the question actually states as much but many ignored this. A fair proportion of answers revealed some understanding but very few referred to energy as well as the materials in an article.

In (d)(ii) answers based on recycling capability were not accepted. Part (d)(iii) was a straightforward question but the 2 marks were not always scored, particularly by the (thankfully few) who carefully described the merits of burying plastics in landfill. It really is important to read the question.

Question 5 Mineral Process Chemistry

The scores awarded showed a wide range of outcomes. The lowest-scoring scripts showed a lack of understanding and knowledge not only of the details of the Special Study itself but also of basic chemistry. Even the higher-scoring scripts made elementary errors of basic fact. Examples included the making of an aqueous solution of copper(II) oxide, the writing of iron ions as Fe^{-} and the reduction of sulphides to sulphates.

The defining characteristics in (a) were seldom described well and there were few attempts at examples in (a)(i). Whilst WO_3 was often correct in (b)(i), W^{6+} was a frequent but disappointing response in (b)(ii). The need for circumspection in (b)(iii) was seldom appreciated and the possible identity of the material in (b)(iv) verged on the grotesque.

Things were rather better in (c) with the calculations and the mining discussion being quite well done. 'Comminution' was known by most. The equation and the chemical detail in the remaining parts were variable in quality.

6256/01

General

The synoptic paper is challenging for candidates, as they have to apply their knowledge to situations which may be unfamiliar, and cannot simply look up answers in their Students' Book. This paper was no exception. Candidates responded well to the challenge with good answers to the calculations in questions 1 and 3, and the standard of organic chemistry in questions 2 and 3 was high. However some of the ideas studied in the AS course had apparently been forgotten; there was difficulty in explaining melting points from structure and bonding, in classifying reactions and predicting bond angles. Topics in A2 which caused difficulty included drawing the structure of polymers and writing half-equations. As usual, marks were lost because candidates did not read the questions carefully, but it was good to see some very clearly expressed answers in good English.

Question 1

The Born Haber cycle in (a) proved to be a comfortable start for most candidates, and many scored full marks. Those who drew clear and properly labelled cycles usually got the calculation right. Common errors were omission of state symbols, particularly for calcium hydride, omission of the label for lattice energy and omission of the factor of two for atomisation and electron affinity of hydrogen. The majority wrote the correct formula for the hydride ion, and even those who gave H^+ generally used electron affinity data. There were few errors in significant figures.

Part (b) was also well done, and the idea of bonds with covalent character was usually described suitably. Only a minority lost marks by referring to aluminium hydride having more covalent bonds. In some cases marks could not be given as it was not clear which of the two compounds in the question had lattice energy values which were closer.

Candidates were often still thinking of covalent character when they answered (c), and based answers on the amount of polarisation in each compound without considering whether the compounds were ionic or not. Those who realised that hydrogen bromide was covalently bonded often said that ionic bonds were stronger than covalent. When the paper was set, it was expected that candidates at this stage could answer without being given separate lines to discuss potassium hydride and hydrogen bromide. However, if the question had been divided, the contrast between melting points of molecular compounds and giant lattices of ions might have been seen more often.

The equation in (d) caused difficulty, and marks were not given unless it included hydride ions as specified. Many candidates did not see which atoms ended up where, and therefore that the hydride ion was gaining a proton and losing an electron.

Question 2

This was a high scoring question, and the only one on the paper where full marks were seen regularly. A significant number of candidates missed the idea that a mixture was being investigated in (a), and drew a chromatogram with two spots side by side. Others gave R_f data, but did not respond to the question by referring to the appearance of the chromatogram. Some stopped after suggesting colours that would be produced with ninhydrin. In (ii), many suggested running the chromatogram again after turning it through 90°. This would not be an improvement unless a different solvent was used. Candidates may not have appreciated this, but they got a mark as long as use of a different solvent was given, and many scored here.

There were many correct answers in (b)(i) showing good understanding. In (ii) it seemed as if the experiment in Topic 18 was not often done. Many candidates thought that amino acids polarised light, rather than rotating the plane of polarisation, and others thought there was a difference in behaviour because one acid was polar. The question was about naturally occurring amino acids, not a mixture of enantiomers, but there was some confusion about whether serine would rotate the polarised light in two directions. Most candidates knew that they had to count hydrogen environments in (iii) though they said this in many different ways. The mark for three peaks in glycine was easier than for the five peaks in serine, as the extra CH_2 in the side chain was missed.

Drawing the dipeptide in (c) scored highly, though as usual some candidates did not read the question and failed to display the peptide bond. Another common error was to draw part of a polymer chain rather than one molecule.

Question 3

Part (a) was well answered. The main errors were in naming 1-chloro-(2)methyl propane, where the number showing the position of chlorine was essential.

In (b) many identified the presence of the hydride ion, and often suggested that hydrogen could attack the benzene ring. A significant number quoted directly from the Students' Book, saying that hydride ions attack carboxylate ions. As a keto group was involved in this reaction this did not get a mark — an example of the need for care in using the text book.

There was a variety of different and interesting approaches to (c) and many high scores. Surprisingly, a significant number did not start by giving the molecular formula of ibuprofen and went straight in to the calculation. Both in this question and in 4(b) candidates tended to round numbers too early, thinking that decimal places were more important than significant figures. This led to the wrong ratio for carbon to hydrogen and loss of marks. Credit was given if the examiners could see what was going on, but if there had been a requirement to explain how the calculation was done and to specify whether numbers referred to masses or moles, and to which element, then marks would have been a lot lower!

In (d) many answers said that groups absorbed infrared radiation, but for marks to be given, a reference to bonds had to be made. The infrared data was used well, and a good proportion of mass spectrometer fragments were given their proper charge. Many responses did not appreciate that a peak not found in ibuprofen was required giving 43 or similar fragments.

Question 4

This proved to be a difficult question and marks were low. In (a)(i) many candidates realised that delocalisation was occurring, though some then spoilt their answer by saying that this occurred over the whole molecule. In (ii) very few answers started by explaining that three sets of bonding electrons round a central atom produce an angle of 120°. The second mark was for explaining that increased electron density in one or two bonds would alter this angle to 122°. Most candidates focussed entirely on lone pairs, and seemed to think that lone pairs on atoms at the end of a bond, rather than on the central atom, are the main factor in determining angles.

Candidates who drew diagrams in (b) (i) often lost marks by showing both oxygens in the carboxylate ion making bonds, which would produce a tetradentate ligand. Others did not mention the involvement of the lone pairs on oxygen, despite the constant reference to them in (a) (ii). There were regular examples of an incorrect conversion of the diagram on page 462 of the Students' Book, which shows 1,2-hydroxybenzene bonding with copper. In the octahedral complex in (ii), many did not apply the information that the ligand is bidentate, and showed six ethanedioate ions. Others included the charges on either the chromium or the ethanedioate, meaning that the formula for the whole ion was written incorrectly. Overall, very few answers were seen to (ii) which gained both marks.

The question gave the information that ethanedioate is oxidized to form carbon dioxide. Many candidates must have searched for cells containing carbon dioxide in their Data Book as the answers to (c) (i) contained carbon dioxide and other species, but not ethanedioate. In (c) (ii) it was expected that candidates would look up values for the two redox reactions in the question, and say that the ethanedioate cell had an electrode potential within these limits. However choice of an alternative cell in (i) led to wrong answers here.

It was disappointing to see so few correct half-equations in (d) (i). The oxidation of ethanedioate to carbon dioxide was often missing, and even the reaction of Fe^{2+} often had electrons on the wrong side, or was shown as producing iron atoms, not Fe^{3+}. Inclusion of equations that referred to various manganate species was common. Many candidates calculated the number of moles in the two solutions correctly in (iii) but, as mentioned in 3 (c), some rounded these numbers and the reacting ratio was therefore wrong. The explanation of the ratio was achieved only by a small percentage, but there were some excellent answers. In (d) (iii) an observation was required, and candidates who did not read the question carefully simply explained autocatalysis. Others related the colour change to the catalyst experiment with cobalt ions and hydrogen peroxide, and many missed the point by saying that the end-point of the titration would be reached faster.

Question 5

This question also proved to be difficult for many. Most candidates gained the first mark in (a), but a lot of confusion followed. Some compared the monomer with polythene; others thought the chlorine atom would cause hydrogen bonding or cross-linking; many said that the C-Cl bond was polar but did not link this with the extra rigidity of the polymer.

The polymer in (b) is difficult to draw without first displaying the formula of

2-hydroxypropanoic acid. Many realised that condensation polymerisation would occur forming ester links, but then drew a polymer containing OH groups rather than –COO links. A significant number suggested that the link was a peptide link even though there is no nitrogen atom in the monomer and there was none in their attempt at drawing the structure of the polymer.
Very few candidates considered the proximity of the bonding pairs in the ring in (c)(i), and most answers referred to the electronegativity of oxygen and the reactivity of the ring towards electrophiles. More than half the polymers drawn in (ii) were correct but many forgot the basic rules about bonding. It was disappointing to see rows of linked triangles after being told that the ring broke open easily, or to see single bonded oxygen atoms joined to a chain of carbon atoms.

Hints for Revision

- In thermochemistry calculations, including Born Haber cycles, state symbols are very important. Enthalpy changes have different values when the state of a substance changes. Always check that you have included the symbols.

- When you are doing calculations, do not round numbers too early. If you have to calculate a ratio, rounding numbers can lead to the wrong value. Think about the formulae C_6H_{12} and C_6H_{14}. The compounds are different but the C:H ratios are very close!

- Practise writing the formulae of condensation polymers. It is helpful to have the formulae of the monomers in front of you, so that you can decide which particles are lost when they react. Polymer formulae should show the "spare" bonds at each end of the section you draw, but dimers should be complete molecules without these "spare" bonds.

- When you write half-equations, balance the atoms first. Add water if oxygen is required, and balance hydrogen with H^+ if the reaction occurs in acid conditions. Only balance the electrons when all the atoms are correct.

- Though you have your book with you in this paper, you need to remind yourself of the topics you did early in the course, as they may be needed in explanations.

Appendix A: Statistics

6251/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	45	40	35	30	26
Uniform boundary mark	90	72	63	54	45	36

6252/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	60	39	35	31	27	23
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	44	40	36	32	29
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	58	52	46	40	34
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	59	53	47	42	37
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	58	52	46	40	34
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	58	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	36	32	28	25	22
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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