

Examiners' Report Summer 2007

GCE

GCE Chemistry (8080/9080)

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Summer 2007

Publications Code UA019017

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6241/01

General

There were minor changes to the style of the paper compared with previous years involving a longer first question designed to test basic knowledge of atomic structure and bonding. Candidates produced the whole range of marks. Many examiners commented on carelessness shown in answers. This was seen in calculations where correct methods were used but inaccurate transferring of numerical data either from the question paper or from earlier working was common. Many candidates showed poor thinking skills and even poorer ability to use language precisely. Many seem not to have read the questions carefully enough and answers showing good chemical knowledge were seen that did not score because they failed to answer the question set. Equation writing was generally poor. Overall the paper was a little more demanding but rewarded those who had learnt and understood their chemistry.

Question 1

Almost all candidates scored highly in (a), the only error being candidates quoting 35 and 34 as the number of electrons in the bromide ion. More able candidates scored the marks for both electron configurations in (b) but weaker candidates made errors in the bromine configuration. Some lost count of the number of electrons while others involved $4d$ rather than $3d$ orbitals. In (c) the reason for bromine isotopes showing identical chemical properties was well understood by many candidates. The most common error was to concentrate on the outer shell electrons, which are common to the entire halogen group, rather than the total number. Some candidates defined *isotope* in terms of different numbers of neutrons, correctly in all cases but not the question asked on the paper.

The instructions and data for the calculation in (e) are clearly presented on the paper but a significant numbers of candidates failed to score full marks even though they carried out the arithmetic correctly. Many transfer errors were seen as well as answers that were probably produced by punching into the calculator the correct figures in the wrong order e.g. 50.45 instead of 50.54. Wrong answers were also produced by rounding too early in the calculation. The question asked specifically for an answer to four significant figures, many candidates chose to ignore the question and quote the answer to 3 significant figures. Marks were also lost where grammes were quoted as units in the answer. The full range of possible bond types was seen but the majority of candidates scored both marks in (f). Common errors were to reverse the answers or give the same bond type for both. Parts (g) and (h) scored well for almost all candidates. The equation in (i) was well known in many cases with only the weakest candidates failing to score. The common errors were to produce NaBr_2 or use Br in place of Br_2 . Fortunately for many candidates state symbols were ignored in the marking. In (j) the bonding in sodium was correctly identified by more able candidates but weaker candidates often quoted it as ionic.

Examiners made reference to the improvement by candidates in the drawing of dot and cross diagrams in (k). The majority of candidates scored 2 or more marks. The most common error was to identify the bonding as ionic and then draw NaBr with a shared pair of electrons. Some answers omitted the charges. Others included the inner shell electrons. This was not penalised provided the electrons were correct.

Incorrect inner shell electrons resulted in a loss of one mark effectively through failure to read the question carefully as did drawing the structure of NaCl.

Question 2

This question proved a real challenge to all but the most able candidates. Many candidates were let down by the lack of precision in their use of language. Part (b) of the question instructs the candidate to use the information in the table to answer the questions that follow. It is vital in questions of this type that time is given to understanding the data and not only that the data be used but that the answer makes clear how the data was used.

The equations in (a), for the decomposition of group 1 nitrates, were poorly done by most candidates. Many did not realise that lithium nitrate decomposes differently from the rest of group 1 and some otherwise good candidates indicated that caesium nitrate would not decompose at all. The lithium product ranged from Li through LiO to LiN or anything that would allow the equation to be balanced.

Both parts of (b) were designed to test the ability of candidates to use information given to predict or explain observations. More able candidates were able to express their ideas clearly and concisely and score well; indicating that in the case of calcium the **reaction** would produce calcium hydroxide which is sparingly soluble so they would **see** a white precipitate, while with barium no precipitate or a colourless solution would be seen. In (b) (i) common errors included stating 'the barium hydroxide precipitate dissolves; that the calcium or barium dissolves; that sulphates were formed'. Weaker candidates chose not to use the information given to answer (ii) and assumed the barium would be used up very quickly, that the acid was not concentrated enough or that barium oxide was produced as the protective layer. Most candidates understood the trend in solubility of the sulphates down the group.

Part (d) was the least well answered question on the paper with few correct equations and even fewer correct state symbols. Candidates were allowed a salvage mark for correct state symbols on a fully correct non-ionic equation.

Question 3

Most candidates were well prepared for (a) (i) of this question. Many based their answers on a correct ionisation equation; backed up by a brief comment 'per mole'. Others gave clear and fully correct definitions in words. Relatively few went on to spoil correct definitions by adding incorrect equations which would have lost a mark. However, some definitions were spoiled by poor use of English, referring to taking "one electron from a mole of atoms or a mole of electrons from one atom" or the omission of the word 'atoms' totally.

In the equation in (a) (ii) there were a range of errors, including the production of negative ions; gaining of electrons; reference to oxygen molecules. A number of candidates, who gained full marks in 3(a) (i), omitted the state symbols in an otherwise correct equation. Some candidates wrote equations converting O to O^{2-} or O_2 to $2O^-$.

Part (b) (i) proved a good test of data analysis. Many candidates expressed their reasoning clearly and scored both marks and then chose the appropriate element (sulphur). Some argued correctly and then stated that X was in Group 7, others argued the graph from back to front and chose Group 1. Many clear arguments were then spoilt by poor choice of element with oxygen and selenium being common wrong answers. This suggests a failure to note the information that X was in Period 3 of the periodic table. In (c) many answers omitted the charge on the S_8 and a significant number ignored what they had already found out about X and chose an element with a mass near 256.

Question 4

The requirement in (a) to **describe** the arrangement of ions/atoms in sodium chloride and graphite instead of being asked to draw a diagram appeared to cause some candidates problems. Communication skills were tested to the full with many weaker candidates unable to put into words what they probably knew. A lack of precision in the use of words such as 'ions' and 'atoms', or failure to describe the actual arrangement of the ions/atoms in the solid were common mistakes. Many candidates gave excellent detailed descriptions of the bonding and the properties of the two solids but failed to score because these were not asked for in the question. In (a) (i) many good diagrams were drawn to help the explanation but some lacked labelling. The best answers described the sodium and chloride ions as being 6:6 co-ordinate. Most candidates dealt with (a) (ii) more competently than (a)(i) describing the existence of layers, and an hexagonal arrangement. Some failed to make it clear that carbon atoms were present and a small number gave detailed descriptions of the structure of diamond.

The link between bonding and use in (b) was generally understood with most candidates scoring at least one mark. Some excellent descriptions were seen but it was sometimes difficult to tell whether the forces/bonds being described were within a layer or between layers. Examples were seen with ionic bonds or hydrogen bonds between the layers.

In (c) conduction of electricity by molten sodium chloride and graphite was well understood by better candidates but weaker answers often suggested molten sodium chloride has delocalised electrons. Some candidates ignored the question and wrote about sodium chloride solution. In the graphite answers it was not always clear where the mobile electrons were flowing and candidates were sometimes confused with their use of the word 'between' when describing where the electrons moved.

Question 5

Most candidates were able to define reduction as decrease in oxidation number but a significant proportion ignored the question and described it in terms of 'electron gain', which although correct, did not score.

The equation in (b) (i) proved a challenge to all but the very best candidates. However, the oxidation numbers were generally calculated correctly for the acid, the oxide, and the hydride but some wrong answers were seen for the salt. Incorrect use of positive and negative signs was seen in some answers. Part (b) (iii) was well-answered by many candidates and discriminated well across the ability range. Weaker candidates lost marks by referring to halogens rather than halides.

Others referred only to sulphur's oxidation states rather than the **changes**. Generalised answers without the use of oxidation numbers were also frequent, despite the clear instruction in the question. Generally where the answer requires use to be made of a previous answer, it is important for the candidate to realise that the marks have already been awarded for the data in the previous part. It is most unlikely that they will be re-awarded in a subsequent response for simply restating them. In this question the candidate was expected to comment on the data by making a relevant comparison **in order to identify a trend** hence the emboldened words in the question.

Question 6

The definition of the term Avogadro's constant was not well understood by many candidates. Those who understood the idea that it is a number often did not express themselves clearly and scored 1 mark. Some just quoted the number (given in the question).

The calculation in (b) was often well done with many candidates getting 40.0. Relatively few candidates made the mistake of adding the unit. However, the identity of Z was sometimes missed with candidates choosing Ca or Zr. Ca ignores the statement in the question that Z is in Group 0 and Zr is based on the atomic number rather than atomic mass.

In (c) it was pleasing to see so many correct answers in (i). Occasionally marks were lost due to inaccurate rounding up and a few candidates failed to quote the unit for the mass obtained. Misreading the question meant that 3.09g was taken to be the mass of KO_2 not H_2O_2 and despite molar masses being given, atomic numbers were used in a few calculations. Some candidates having obtained full marks for the mass of KO_2 did not go on to gain the mark for the volume of oxygen in (ii). This was often due to an incorrect unit, but occasionally because they had divided the moles of oxygen by the molar volume instead of multiplying. In some cases in both (b) and (c) the working was not clearly laid out with numbers appearing as if from nowhere. In such cases it is difficult for examiners to salvage 'working' marks for partially correct calculations.

Hints for revision

- In calculations make sure you have correctly transferred data from the question or from your earlier working to the answer and to your calculator. Do NOT round answers up or down on the way through the calculation.
- Make sure you take note of clues in the question such as the use of **bold** printing. They are there to help you concentrate on the material required in the answer.
- Always check at the end of a question or part question that you have used all the information and not contradicted yourself in the answer.
- Do not assume that because a question deals with similar chemistry to a previous year's question that a previous answer will do.
- When asked to make use of information or data given in a question make sure you use it and show clearly how you have used the information.
- Learn the equations.

6242/01

General

This paper contained some straightforward questions that were accessible to all candidates and some more demanding questions to stretch those with higher ability. Many examiners commented on the poor quality of written communication shown by many candidates. Many candidates lost marks by not explaining their answers clearly. Marks were also lost through careless errors and not reading the questions carefully, rather than a lack of knowledge. Candidates should be reminded that all equations should be balanced, state symbols should be included in all thermochemical equations, calculations should have clear working and numerical answers should include the correct unit.

Question 1

This was a straightforward question, mainly testing recall of the manufacture of chlorine in a membrane cell and those candidates who had revised this scored full marks. There were some incorrect anode reactions involving sodium, hydrogen or even the evolution of oxygen. The explanation of why the anode reaction was oxidation was not done well by many candidates as they just quoted the stock phrase 'loss of electrons' without explaining what is losing the electrons or they referred to chlorine rather than the chloride ions; those answering in terms of oxidation numbers usually scored the mark. There were many poor equations for the overall decomposition of brine; some had the correct species but were unbalanced and quite a few made hydrochloric acid and sodium hydroxide from sodium chloride and water.

Question 2

The required structure was drawn correctly by most candidates. The majority deduced that C-F bonds are stronger than C-Cl bonds but some then added that this is caused by the high electronegativity of fluorine, which is incorrect, so they lost the mark. A surprising number of candidates could not explain what a free radical is; some explained how they are formed and others thought they had a single electron, a lone pair of electrons or even a pair of unpaired electrons. If they referred to a species, neutral was also expected as there are many species possessing an unpaired electron that are not free radicals e.g. Cu^{2+} . Many candidates did not realise that uv radiation is needed to produce free radicals. Some candidates stated that a high temperature is needed to produce free radicals but this question referred to the stratosphere where the temperature is very low. The repeating units of the two polymers were drawn well by many, with the most common errors: drawing too many chlorine atoms in PVC, including hydrogen in PTFE, showing double bonds in both polymers, drawing more than one repeating unit and not showing the extension bonds. There were a very large number of acceptable uses of polymers, but some candidates are still writing 'in plastics' or general packaging, plastic bags etc. Candidates should be encouraged to investigate specific uses of polymers and relate them to their properties.

Question 3

Many candidates scored full marks for the names and homologous series required in (a). However, some forgot the rule for selecting the longest carbon chain when naming alkanes and 2-ethylbutane was a common error. A few candidates were

unfamiliar with the term 'homologous series' and gave the general formula instead. The majority of candidates could draw the structural and geometrical isomers of $C_2H_2Cl_2$, although the main error was to draw the geometric isomers in (i) and (ii). Many candidates could explain why geometric isomerism can occur, but there were some poor explanations where it was not clear if the double bond or the molecule was unable to rotate. A few candidates were under the impression that the isomers existed because rotation about the double bond was possible. Explanations in terms of different groups on the carbons of the double bond were often worded badly and failed to score the mark. Many candidates could classify the reactions in (c), although candidates should be reminded that 'classify an organic reaction' needs to include the type of reagent as well as the type of reaction. A surprising number of candidates gave the molecular formula of the hydrocarbon as $5CH_2$ and others tried to write a structural formula. A careless error that was seen frequently was C_5H_{10} .

Question 4

Many candidates could complete the calculation in (a) correctly. However, a significant number just multiplied and divided 1000, 219 and 16 without thinking about what they were trying to calculate. Other common errors included: using 4.18 because they were trying to do an enthalpy calculation (this value will be given in the question if it is required), incorrect molar masses for methane, 12, 14, 18 and 20 were commonly seen and dividing 1000 by 219 and writing grams by the answer. The reaction profile for the reaction was drawn well by many candidates, with just a few drawing a Maxwell-Boltzmann distribution. However, some candidates misunderstood the role of the ultraviolet light and assumed it was a catalyst so drew two curves. Some candidates drew a general reaction profile but they should always use the specific reactants, products and enthalpy change given in the question. There were some poor arrows for the enthalpy change which did not start or end at the correct place; some arrows even started at the top of the activation energy maximum. The explanations were often poorly expressed and written in general terms rather than for this specific reaction. 'The uv light gives the molecules enough energy to overcome the activation energy' was a frequent answer that did not score any marks. The specific role of the uv light was required for the final mark and the candidates could have used the link back to question 2 where chlorine free radicals were produced. Part (c) was answered well by many candidates who read the question carefully. Too many candidates just discussed which way the equilibrium position would move and did not answer the question of the effect it would have on the yield of hydrogen. Some candidates stated the yield of hydrogen would be higher at a higher temperature because the rate increased and received no marks as they did not refer to the effect on the equilibrium. Some candidates contradicted themselves by saying that the equilibrium moved to the right and the yield of hydrogen decreased. Many candidates wasted time by commenting on thermodynamic stability, which was not asked in this question.

Question 5

Many candidates are familiar with enthalpy change definitions and were able to score full marks in (a). However, there are some who do not specify what standard conditions are or do it incorrectly, some just referred to a compound, some do not mention complete combustion and others who think that enthalpy of combustion is energy required to burn a substance. The Hess's Law cycle was drawn to help candidates but there were quite a few who did not know what to write as labels for

the arrows (numbers or symbols are acceptable) and even more who did not realize that the products of the reactions, $2\text{CO}_2(\text{g})$ and $3\text{H}_2\text{O}(\text{l})$, should have been put in the box at the bottom. Of those that were familiar with Hess's Law cycles and did include the correct products, a large number omitted the balancing and/or state symbols. Candidates should be reminded that state symbols are required for all thermochemical equations. Many candidates could complete the calculation from the cycle correctly, although common errors included: ignoring the cycle and using $\Delta H_{\text{reaction}} = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$, not multiplying the energy changes by the number of moles and incorrect arithmetic. The reagents in (c) were often well-known and many candidates scored full marks.

Question 6

The majority of candidates could balance the equation correctly and identify the catalyst used, although iron was a common wrong answer. Many answers to (a)(iii) were poorly explained and did not answer the question. Some candidates discussed the effect of decreasing temperature on the equilibrium position and others ignored the question and discussed the effect of an increase in temperature. This type of question often follows a diagram of a Maxwell-Boltzmann distribution and although that was not required here, the detailed explanation in terms of lower energy of the molecules (not reactants), fewer molecules with energy greater than the activation energy and a smaller proportion of collisions resulting in a reaction was still required. It was not unusual to read long answers that had no reference to activation energy and just referred to fewer successful collisions. Many candidates knew how to convert nitrogen monoxide into nitric acid, although quite a lot omitted cooling or put it in the wrong place. Some candidates wrote incorrect equations for the reactions and quite a few candidates thought that the nitrogen dioxide just dissolves in water and did not refer to a reaction, although this mark could be salvaged with an equation. A significant number of candidates gave NO_3 as the intermediate and H_2NO_3 as the formula for nitric acid. Uses of nitric acid were well-known but were poorly written so did not score a mark. Nitric acid is not a fertilizer, but it is used to make fertilizers.

Hints for revision

- Learn, or practice working out, formulae and make sure you can balance equations.
- Learn the details of the industrial chemistry processes in the specification.
- Read the questions carefully and make sure you have answered what is being asked.
- Think about your answer before you write it down and make sure that it will make sense to the examiner marking your paper.
- Check your answers to eliminate careless errors.

6243/01 (Coursework)

General

Since the current scheme of assessment was revised in 2003 its administration and implementation by centres has greatly improved. Most centres now use exclusively Edexcel exercises. The amount of annotation, including the use of marking grids, is now more detailed and easy to follow by moderators. The sample sent to moderators is generally well organised and includes the correct necessary documentation. Centre assessors must take credit for this improvement although it is hoped that the annual feedback from moderators to centres has helped.

Centres that have received reports with no negative comments may assume that they are implementing the scheme correctly and that their marks will not be altered. Those centres with reports that list some shortcomings need to take action to address these.

Comments on the administration of the scheme

There follows a list of points made in response to work seen from a few centres in this session.

- Record cards are no longer valid Edexcel documents. They have been replaced with record sheets a copy of which has been included in previous Examiners' Reports.
- The sample of work sent to the moderator should include only the work for each candidate that has counted towards the total mark.
- Only the work of the candidates asterisked on the OPTEMS plus, if appropriate, that of the candidates gaining the highest and lowest marks should be included in the sample sent to the moderator. There is no point in sending any extra work since the moderator will not look at it.
- The mark for an organic exercise should be included in the mark profile for every candidate.
- It remains a cause of concern to the moderators that there are some centres in which candidates apparently have access to reference materials when carrying out the planning exercise for an ability A mark. This is not allowed by the scheme. A detailed explanation of how ability A should be assessed is given on page 9 of the 2005 Examiners' Report.
- The use of numbered ticks is greatly appreciated by the moderators and is likely to lead to more accurate marking by the centre assessor. Numbered ticks make it easy for the moderator to follow the award of marks, especially in a planning exercise.

Comments on the assessment exercises.

- In response to requests from centres an acid-base titration has been added to the 8080 list of exercises- AS15, Acid-base titration, Finding the molar mass of a solid acid. This allows ability B to be assessed. Any centre that wishes to obtain a copy of this exercise, complete with mark scheme and grid should contact the coursework section at Edexcel at coursework@edexcel.org.uk
- It is not necessary to word process any exercise. If the ability A planning exercise is word-processed this must be done under supervised conditions.

- The moderators can only check that accuracy marks for ability B have been properly awarded if the centre assessor supplies a value of a titre or temperature change against which a candidate's value may be compared. If such a value is not supplied the moderator is likely to ask the centre to supply a value.
- Centre assessors may use some discretion when marking observations in ability C exercises. However "clear" should never be awarded a mark when "colourless" is required. "Gas evolved" is not an accepted observation. Rather "bubbles" or "effervescence" should be recorded.

It remains a requirement of the scheme that the two ability B exercises should, as far as possible, test different laboratory skills. Acceptable combinations of ability B exercise include AS2(or AS15) and AS4; AS1 and AS7; AS1 and AS6(or AS7).

Corrections

In September, 2003, a letter was sent to centres listing a number of amendments to the exercises in the Internal Assessment of Practical Coursework for AS GCE Chemistry(8080) booklet issue 2 (January 2003). Some centres seem to be unaware of these amendments. For the benefit of these centres the most relevant points are listed below.

1. Page 6, calculations. Molar mass B = 106 / g mol⁻¹
2. Pages 56 and 59, AS12 2(b) Potassium dichromate(VI)
3. Page 57, 3(a) In the spaces provided below write your suggested formulae for the functional groups present in W, X, Y and Z.

Hints for carrying out coursework

- In a titration you should be able to make the indicator change colour at the end point by the addition of one drop of solution from the burette.
- When adding a second reagent to a test tube, gently shake the tube as you do so.
- Corrections to assessment exercises are not allowed. Once you have handed in an exercise it will not be returned to you.
- The inference from a flame test is best written as the formula of the metal ion eg Na⁺ or K⁺.

6243/01 A/B/C

General

The AS practical paper contained four questions, of which one was a written [no-executed] plan. This format has stood the test of time, but centres should be aware that the practical components are not in a fixed framework. The requirement is that the majority of marks are available for quantitative work, with some small award for qualitative.

Question 1

Groups 1 and 2 were similar in that candidates were provided with an inorganic salt and an organic liquid to test. The anion in the former was a component atom in the latter. Candidates were directed to hydrolyse the liquid and determine the atom by inference from the test for the corresponding anion released by the substitution reaction. This subtlety was lost on the vast majority of candidates, who saw “silver nitrate” and inferred a halide ion rather than make a conclusion about the unknown liquid. Very few correctly inferred that the unknown was a haloalkane.

A similar problem was encountered with (b) (ii) which requested the identity of the functional group in the unknown *after* hydrolysis. Many wrote “hydroxide” rather than “hydroxy(l)” as required. In (b) (iii) candidates should be aware that “no change” is a valid observation and can lead to meaningful inferences. Once again there was evidence of unthinking replies from candidates who, seeing that the oxidising medium had changed colour [Group 2] included “aldehyde” in their suggestions of the identity of the organic product from the hydrolysis.

Question 2

In the question candidates had to make up a solution and use this to determine another. This led to the possibility of a wide range of acceptable titres. Despite the issue raised concerning the supplied methyl orange indicator [Group 1] candidates managed well with this exercise. Some still do not read the burette to 0.05 cm^3 , and fail to take appropriately concordant readings from which to calculate a mean. Given the problems alluded to above concerning calculation of molar mass, the calculation was generally well done. Given the detailed structure this was no surprise. Candidates should be aware of the need to quote their final answers to a number of significant figures appropriate to their data.

Question 3

The thermochemistry exercise was based upon a simple displacement reaction. Very few candidates failed to provide a full set of temperature data. Part (b) was discriminating; many candidates stated that the zinc was in excess, but failed to give a sound reason. The colourless solution is visible after the reaction has subsided. It is clear that for too many candidates the graphical manipulation and interpretation of data is very difficult. Non-linear scales and missing points are just two of the potential pitfalls into which too many stumble. The choice of scale on the ordinate axis was left to the candidates, and some provided a range that made interpolation extremely difficult. The extrapolation of lines to the mixing point was

also a surprising problem, with those that had chosen an odd scale now securing a penalty in their reading of it.

Part (d) (ii) proved difficult, with common errors being the absence of the negative sign, despite it being printed in the text. Part (d) (iii) perhaps could have benefitted from an extra line or two, but nevertheless it was a difficult question. There was much muddled writing with vague references to temperature changes and enthalpy changes which meant that the candidates' meaning was lost.

It is clear that the majority of candidates are well trained in the expected practical techniques, but fail to understand questions about the theory behind the exercises. Candidate's understanding of the word "accuracy" is very shaky indeed.

Question 4

The planning question is inevitably the one which candidates find most difficult. Some were very good, but others lacked clarity and so scored few marks: for example not washing and drying the precipitate. Many showed calculations to give % potassium sulphate rather than % sulphate ion and % barium chloride rather than % barium ion.

Hints for revision

- In analysis questions do recognise the importance of the stem to the question, and of the inferences required.
- Burettes may be read to 0.05 cm^3 , and the mean should be calculated from concordant titres only
- Scales on graphs need to be easy to interpolate; cover the range of data to be plotted and in this case allow sensible extrapolation.
- All data points should be plotted
- Plans should be written as if it is for another AS student to follow. Details of what data to collect and what to do with it should follow a brief summary of the procedural points.

6243/02

General

The June 2007 paper was of a similar standard to previous papers in the series, testing similar skills using questions which were mostly of a standard type, some very straightforward others more demanding. There was no formal experimental plan on this paper. The paper discriminated effectively between candidates at the various levels and offered a range of scoring opportunities for the reasonably well-prepared candidates. The Quality of Written Communication was tested very effectively both in those questions that required some extended transactional writing and in the calculation questions; in both situations the more successful candidates focused on relevant material and set out their answers clearly and concisely. Many candidates had difficulties with significant figures with considerable confusion evident between this concept and the number of decimal places; some (mainly weaker) candidates also truncated numbers; the practice of rounding intermediate numbers in a calculation was common. Some candidates seem to neglect the practical aspects of this paper or simply showed too little knowledge or awareness of elementary practical procedures in framing their answers. In calculations some candidates did not consider the plausibility of their answers.

Question 1

This standard question on qualitative analysis proved demanding for all but the best candidates with the unknown salts being frequently mis-identified despite correct answers to some components of the question. While A was correctly identified as an ammonium salt, the anion was often wrong; candidates frequently gave incorrect names or formulae in their answers and sometimes a mixture of correct name and incorrect formula (or vice versa). Compound D was often given as potassium nitrate and E as nitrogen dioxide even when F was correctly identified.

Question 2

While the basic principles involved in the separation required in Q2 (a) was well understood by most candidates, the methods often lacked key practical details; in particular few appreciated the need to wash the filtered residue. While many candidates understood the importance of calculating the minimum volume of water needed to dissolve the sodium carbonate in the mixture, it was extremely rare to see any awareness of the practical problems that would be associated with trying to mix 110 g of a solid with about 50 cm³ of water. Candidates at all levels devoted space to descriptions of the isolation of sodium carbonate from the solution. Some candidates gave detailed descriptions of re-crystallisation, usually implying that calcium carbonate would dissolve. In (b) the idea of using a flame test to check for the presence of any residual sodium carbonate was well understood although some candidates suggested adding acid and testing for carbon dioxide or weighing the product to show that 100 g of calcium carbonate had been recovered.

Question 3

In Q3 (a), (b) and (c) the standard tests for organic compounds and their results were very well known. Very few candidates mentioned that the nitric acid used in (a) would need to be in excess for the test to work and, despite the clear requirement to identify an atom, a number of candidates referred to 'chloride' or Cl₂ rather than chlorine. In (c) failure to state a specific observation often resulted in the loss of a mark (the responses 'no change' or 'no reaction' or 'no observation')

were frequent). Many candidates identified Y as a tertiary compound but were unable to draw the structure as required in (d); some drew a branched chain primary structure and a few a simple primary structures with the carbon-chlorine bond perpendicular to the chain but the most common alternative to the correct structure was the secondary compound. A significant number of candidates gave an alcohol rather than the chloro-alkane.

Question 4

In Q4 (a) steps required for an accurate titration were well known and there were some excellent answers giving a clear and concise account of the procedure; the practical need to titrate the alkali rapidly to near the end-point and then drop by drop was the most likely omission. However, candidates at all levels burdened themselves unnecessarily with elaborate descriptions of preparing the titration apparatus despite the clear indication in the question that these were not required. Many candidates would benefit from a greater familiarity with the standard vocabulary of titration. The most frequent error in (b) (i) was the use of the titre volume rather than the burette reading. Most candidates correctly identified the concordant titres required for (b) (ii) and calculated the mean. In (c) the mole calculation sequence produced a wide range of responses in which the commonest errors were failure to use a factor of 1000 in (c) (i) and (c) (iii), incorrectly calculating the number of moles of NaOH (often using the M_r with the mean titre in (c) (ii)] and using the wrong volume in the calculation of the final concentration. In (c) (iii)) failure to quote the answer to three significant figures was quite common; some candidates simply omitted this requirement while others quoted to two significant figures. Some candidates gave the very large or very small answers which resulted from calculation errors without seeming to consider their feasibility

Question 5

In Q5 (a) most candidates were able to calculate the enthalpy of combustion by following the steps of the structured calculation, confusing joules and kilojoules or assigning an incorrect sign were common errors. In (b) (i) most candidates understood how to calculate a percentage error but a number failed to note the need to consider a temperature **change**, and calculated a value of 2.33%. In (b) (ii) candidates usually calculated the temperature change from first principles rather than using their percentage error. In (c) (i) some candidates at all levels suggested that the mass loss was a consequence of combustion but in (c) (ii) the nature of the black deposit and the effect on the value of the enthalpy of combustion were well understood although a sizeable minority of those candidates who ventured an explanation for the change in the value believed that the reduction in the measured value was due to the carbon affecting the heat transfer.

Question 6

In Q6 (a) (i) the apparatus set-ups were usually identified correctly although a significant number of candidates believed the second apparatus was for fractional distillation. The answers to (a) (ii) revealed some misconceptions: a number of candidates believed that the reflux apparatus needed to be open to allow gas, air or even heat to escape and some who appreciated that the pressure would increase considered the release of pressure and vapours to be synonymous. In (b) (i) few candidates at any level were able to explain the need to add iodine slowly, many suggesting that this would speed up the reaction by reducing the surface area of the iodine and some that this would ensure complete reaction. In answering (b) (ii) some candidates did not make use of the information on ethanol and iodoethane

and relied on vague generalisations such as ‘all organic compounds are flammable’ others suggested that the main benefit of the water bath was in controlling the temperature. In contrast the need for prolonged heating was well understood. Even the best candidates found it difficult to suggest a suitable temperature range for the distillation and very wide ranges and ranges which started or finished with the boiling point were quite common. The calculations in (c) proved quite demanding. In (c) (i) candidates frequently used the A_r of iodine rather than M_r , while only the better candidates were able to work out the correct mole ratio for (c) (ii) with many candidates ignoring the mole ratio altogether. Calculating the percentage yield for (c) (iii) was straightforward but the many candidates who had calculated a maximum mass of iodoethane that was less than the yield stated in the question usually just inverted the ratio. Here, as elsewhere on the paper, candidates were often not alerted to review their calculations by implausibly large or small answers.

Hints for revision

- Remember that when colour changes are required the start and finish colours should be given.
- Practise setting out calculations clearly, showing essential working, retaining intermediate numbers fully and rounding only at the end of a calculation.
- Ensure that you understand significant figures, particularly the difference between significant figures and decimal places.
- Check that you understand what is meant by primary, secondary and tertiary as applied to the compounds that appear in the AS specification.

6244/01

General

This paper had many straightforward questions that all candidates could access, but it was also sufficiently challenging for the most able who were given an opportunity to show the extent of their knowledge and understanding of the Unit. Several questions produced responses lacking precision, with words such as ion and molecule used interchangeably. Examiners noted that some candidates did not complete their explanations when trying to promulgate an argument, while other candidates included extraneous contradictory material in their answers.

Question 1

Part (a)(i) provided a good start for many candidates. In (a)(ii), the enthalpy changes in the cycle were well known, with the exception of ΔH_3 . This was the sum of the first plus second electron affinities for oxygen. ΔH_3 was frequently described incorrectly as “the electron affinity of O” or “twice the first electron affinity of oxygen.” The correct lattice energy value of $-3844 \text{ kJ mol}^{-1}$ was by far the most usual answer to (a)(iii). Examiners sometimes saw negative signs appearing and disappearing from candidates’ answers, without any explanation. These adjustments often occurred when the expression given for the lattice energy had not correctly taken into account the direction of the arrows on the cycle. In (b)(i), some candidates thought that the anion polarised the cation rather than the other way round. In (b)(ii), both the size and charge of the ion had to be mentioned; a substantial number referred solely to “charge density.” If this term is used, it should always be followed by an explanation. In (b)(iii), many candidates realised that magnesium iodide had covalent character. The importance of clear English was highlighted in this question. Examiners saw many contradictory answers, in which the words atom, ion and molecule were used interchangeably. Many candidates acknowledged, in (b)(iii), that the theoretical lattice energy was different from the experimental value, rather than stating that the theoretical value was less exothermic than the experimental (ie Born-Haber) value. In (c)(i), most candidates obtained at least one of the two marks available for the definition of the enthalpy of hydration. Part (c)(ii) proved to be discriminating. Some candidates made no reference to the data provided at all, whereas others just referred to a “balance between lattice energy and hydration enthalpy.” A significant number of answers failed to make any link between the solubility and the enthalpy of solution of the compounds.

Question 2

This question provided candidates, who had thoroughly learnt and understood the organic section of the Unit, with an opportunity to score high marks. In (a), many candidates who knew the identity of the products then did not display all bonds when drawing the structural formulae, as specifically requested in the question. In (b), it was pleasing to see the reagents correctly recalled so often by the candidates. Of the five steps, the dehydration of the amide (Step D) proved to be the most problematic. In (c)(i), the most frequent incorrect response was an “ester” instead of an “amide.” In (c)(ii), the requirement to show “sufficient of the polymer chain to make its structure clear”, rather than just the “repeating unit”, appeared to be welcomed by many candidates. Part

(d) proved discriminating, with the majority of incorrect responses suggesting the formation of a chloroalkane in the first stage.

Question 3

In (a), relatively few of the pH curves drawn warranted full marks. The vertical section of the curve was frequently shown when a volume other than 25.0 cm³ of ammonia solution had been added. Whilst the initial pH of the hydrochloric acid (pH = 1) was often deduced correctly, the final pH of the solution was then shown at too high a value (often pH 13 to 14). A curve more appropriate to a weak acid/strong base titration was often sketched. Consequential marking frequently enabled a mark to be scored in (b) for the choice of a suitable indicator, despite an incorrect answer to (a). Part (c) proved to be highly discriminating, although it was disappointing to see so many candidates state that “ammonia is a strong base” or “ethanoic acid is a strong acid”, despite having encountered these substances in many GCSE courses.

Question 4

In (a), the structure of the ester was often correctly drawn and (b) was correct in many of the scripts submitted. In (c)(i), a significant number of candidates were unable to deduce the number of moles of each component present at equilibrium. Consequential marking allowed credit to be earned in (c)(iii), although the necessity to introduce the volume of the equilibrium mixture (which cancels out in the K_c expression), to convert equilibrium moles to equilibrium concentrations, was frequently overlooked. In (d)(i), many candidates realised that the equilibrium position, for the endothermic reaction given, would shift to the left when the temperature was lowered, but did not realise that the position of equilibrium adjusted **because** the value of K_c had decreased rather than the converse argument.

Question 5

Part (a)(i) was very often answered correctly, with fewer candidates than in previous examinations erroneously including hydrogen as a product of the reaction between sodium oxide and water. Part (b)(i) was found to be far more difficult, with the formula of phosphoric(V) acid proving elusive to many candidates. The quality of written communication affected many answers to (c), with a sizeable number of candidates incorrectly referring to the acid-base properties of the elements rather than the oxides of the elements. In (d)(i), only equations that showed the formation of either the hydrogen ion (H⁺) or the oxonium ion (H₃O⁺) were credited. In (d)(ii), the equation showing the reaction of lead(II) oxide with dilute nitric acid was more than twice as often given correctly when compared with the equation for the reaction of this oxide with dilute sodium hydroxide. In (e), a lack of precision was the main reason for marks not being awarded (eg “the elements become larger as the group is descended”).

Question 6

In (a) (i), (ii) and (iii) were arranged in order of an increasing incline of difficulty. The formula of the product of the reaction between propanal and hydrogen cyanide was often shown incorrectly in (a)(iii), even when the type of reaction (nucleophilic addition) had been correctly given. In (b) and (c), those who had

learnt the reactions of Grignard reagents were handsomely rewarded. In (b)(ii), when asked for the conditions, some candidates proposed a mixture of dry ether and dilute acid together, instead of making it clear that the intermediate compound was subsequently hydrolysed. In (c)(i), the correct tertiary and secondary alcohols were frequently drawn, but the naming of the compounds proved to be surprisingly difficult for many candidates. Part (c)(ii) proved to be discriminating, with relatively few candidates realising that the aldehyde group on the molecule was planar and that it would therefore be attacked with equal probability from two directions.

Hints For Revision

- For more complex explanations, such as the reasons for the difference in theoretical and experimental lattice energy values, write out the important facts as bullet points when revising.
- Learn the reagents and conditions for all of the organic reactions in this Unit (and in Unit 2).
- Practise working out the number of moles of every component present in an equilibrium mixture.
- Practise drawing pH curves, giving due consideration to starting and finishing pH values.
- Practise naming organic compounds studied in this Unit (and in Unit 2).

6245/01

General

Many candidates gave a good account of themselves on this paper, with the weakest parts being in the electrochemistry. Calculations were generally tackled with confidence, and the organic chemistry was often well-known. Unsurprisingly the weaker scripts often showed that candidates had not read the questions carefully enough and did not understand the depth of treatment that was expected.

This year, for the first time, scripts with attached sheets were entirely scanned and marked using the ePEN system. Some candidates failed to draw examiners' attention to answers on the attached sheet; procedures are in place to ensure that such answers are marked, but examiners' work would be made easier if candidates said within the clip of the item that extra sheets had been used. If candidates go out of clip it is clearly in their own interests for them to say where examiners should look, and to do so within that clip.

Previous reports have commented on a general improvement in layout, especially of calculations, over the past few years. Whilst this still holds for the majority, a significant minority of scripts showed little regard for clarity of writing and scant help was offered to make calculations intelligible. If examiners can see where mistakes are made, then marks can be often be awarded consequentially. The standard of drawing of apparatus was generally very poor, and candidates need practice in this skill both for neatness but also to understand the structure and function of the apparatus that they use. Too many candidates do not know the conventions for drawing 3-D molecular structures.

Question 1

Most candidates were able to offer some useful answers to each part of this question. In (a), where they were required to say what they *see*, a significant number said 'colourless gas evolved', yet did not say how they could know this. Most knew that **W** is an acid. Many also knew that it is an alkene, so gave the correct colour change for bromine water with the correct reason. Some referred only to 'the double bond' without mentioning carbon. Many fewer recognised that the phenolic function would also produce a white precipitate.

Nearly all recognised in (b) that **W** shows geometric isomerism; fewer were able to spot also that there is a chiral centre so that the molecule has two enantiomers. Thus it was common to find two isomers mentioned, not four. The explanation as to why **W** shows optical isomerism did not always state the non-superimposability of the mirror images which is the necessary and sufficient condition. Many talked about the rotation of plane polarised light, which was not the question.

The test for chlorine in **W** was described well by many candidates. Some did not mention the need to **acidify** the solution with nitric acid after addition of sodium hydroxide, and there was the inevitable crop of answers that added the correct solutions but in an order that could not possibly work. These were in the minority. A small number of candidates suggested the use of mass spectroscopy, but were unclear about what would be seen. In principle the method is sound; however most suggested that a peak should be sought at m/e 35.5 .

Question 2

Many candidates started this question well, but faded as the question progressed. Most derived the orders of reaction correctly, with only a few not making their working clear though with more than a few writing answers which were extraordinarily messy. Some did not appreciate that experimental error would suggest that an order of, say, 0.97 is likely to be 1. Virtually all gave correct answers (consequentially in some cases) for the rate equation.

A surprisingly large number calculated the rate constant correctly, but not for **experiment 3**, as was asked. Many of these produced the correct units, however.

Candidates answered (b) rather poorly on the whole. The point that the kinetic energy of the molecules will increase was almost universally appreciated, but not that increasing the temperature increases the **proportion** of molecules that have sufficient energy to produce a successful collision. Candidates will say that more molecules have the necessary activation energy, but over the whole time that the reaction takes this statement is not true. The 'more of' or 'greater proportion of' wording is needed if the reaction mixture is being considered at a given time. Many suggested with sensible reasons the number of steps there might be in the mechanism, some good answers offering intelligent ideas as to what the mechanism could be.

Part (c), concerning the Arrhenius equation, was sometimes done simply and accurately by using the gradient of the graph, as was the intention. Some candidates did not recognise that this value is negative; others were rather cavalier with signs and dropped the negative, or ignored it, according to expediency. A few used very small triangles to calculate the gradient with significant errors in the final answer being the result. A minority gave final answers in units other than those explicitly asked for, and some believe that activation energies can be negative. A further group of candidates did not use the gradient route, but wrote the full equations for two different points on the graph and then eliminated $\ln A$. Done correctly this produced perfectly good answers, albeit rather laboriously, for a significant minority. A few could not see how to eliminate the logarithmic term, however, so they either ignored it or included it as a constant in the final answer.

Question 3

The electrochemistry in this question produced significant difficulties for many candidates, with few showing a full understanding of what the information in the question enables them to do, or of what some of the answers that they get actually mean.

In (a)(i) the majority of candidates derived the equation for the reaction between zinc and nitric acid correctly and gave the correct value for the cell potential. However in part (ii) hardly anyone calculated the cell potential for the reaction of zinc with hydrogen ions and then compared it with the potential obtained in (i) so as to explain the observed reaction. Many answers showed that candidates were not thinking about the chemistry of zinc at all, else there would not have been the significant number who said that zinc does not react with acid to give hydrogen. A clear understanding of the relevance of the hydrogen electrode as a standard electrode was needed for this question.

There was much confusion between thermodynamics and kinetics; many candidates clearly believe that the value of the potential says something about rate. The canard that some potential (0.03V, 0.3V, 0.4V, 0.6V were all seen) would render a reaction improbable, even though feasible, was seen too often. A potential of 0.3V for a two-electron change gives a value of K of the order of 10^{10} at 298K, feasible by any standards.

In (iii) many candidates named the complex correctly and drew it acceptably, though a minority was unable to give a convincing 3-D representation of an octahedral complex. Some candidates used wedges and dotted lines in a random manner, not realising that there are conventions for this notation. Although candidates were not penalised if their ion lacked a charge, too many of the 'ions' did.

The reaction of concentrated hydrochloric acid with $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ was correctly understood, and the equation given, by a significant minority. Many more knew that it is a ligand exchange reaction, but did not know the equation. These two types of answer accounted for perhaps just over half the responses; the remainder thought that the reaction is a deprotonation, so had not recognised one of the principal properties of concentrated hydrochloric acid.

In (b), where the reaction of copper(II) ions with iodide ions was explored, virtually all were able to say why the reaction would not be thought feasible. However the majority was unable to suggest why the reaction does occur, simply offering the idea that 'conditions are not standard'. A few did understand that CuI is precipitated and that therefore the equilibrium is shifted in favour of the products, but this answer was rare. The impression given throughout the electrochemistry answers was that the values of E^\ominus are, for many, simply quantities that are used to trot out 'feasible' or 'not feasible'. The relationship between the potential and the position of equilibrium was rarely mentioned and, examiners felt, rarely realised.

Many candidates recognised the existence of copper(I) ions in the solution formed in (iii), but sadly failed to include the ammonia ligands. It was rare to see the complex correctly represented, but this did not prevent many good answers in (iv) where oxidation to copper(II) by oxygen was widely known. A few answers with 'aerial oxidation' were given, but the reagent needs more precise identification.

The use of starch as an indicator and its colour change for iodine titrations was widely known; the interlopers were phenolphthalein and methyl orange, inevitably, but not commonly. However in (ii) very few indeed knew that an irreversibly **insoluble** complex is formed between starch and iodine if the latter's concentration is too high, leading to a low value for the titre. This last point about the titre, critical in the context, was seldom seen.

A large number of correct answers were seen to the titration calculation; many others showed only one error, usually either some stoichiometry fault between iodine and copper or a failure to multiply by 10. The introduction has already commented that the layout of some answers left much to be desired, and sometimes much to be guessed at.

Question 4

Most candidates knew the reagent and catalyst needed to make methylbenzene from benzene; the best answers specified **anhydrous** aluminium chloride.

Every reaction type known appeared in (b)(i), though the majority chose correctly. In (ii) the mechanism was known by many candidates, though it was not always laid out very clearly or logically. It did not matter whether single-headed curly arrows were used or not, but of those who did use them a large number were rather stylised. Such decorative curlicues did not always add to the clarity of the answer. A significant minority gave only one of the propagation steps; and those candidates who scored poorly usually did so because of involvement of hydrogen radicals or of ions. Such answers scored mainly for the initiation step and its reverse as the termination step. Some candidates tried to cascade the various stages into one long 'equation', but these usually omitted some necessary substance such as HCl. In multi-step mechanisms it is better for each step to be shown completely separately, so that the product from the first step is then re-written for the start of the second.

The poor quality of many of the diagrams of the apparatus for making chloromethylbenzene has been mentioned earlier. Apparatus should be drawn in section, not as an attempt at a 3-D sketch. Apparatus to challenge the most ingenious of glassblowers was not uncommon, and frequently the standard of drawing received at best cursory attention. Significant numbers of answers were scarcely better than a scrawl, leading examiners to bemoan the lost art of drawing chemical apparatus. Some candidates drew condensers with no centre tube, or did not show the chlorine inlet under the liquid surface. Molecules do not know where they are supposed to go, so candidates need to consider the function of everything that they draw.

The structural formula of the nitrile **A** in (c)(ii) was known by virtually everyone. Most were also able to suggest a hydrolysis reagent in (ii) together with suitable conditions. However conversion to the **ethyl** ester requires ethanol specifically, so it was surprising how many candidates merely chose 'alcohol' in (iii).

Many sound answers were seen for the mass spectrum question; candidates were able to deduce the ion and a structure from which it arose. There were some who failed to show the ion's charge, or who made it negative; and some who left hydrogen atoms out of their structures or who ignored the molecular formula given in the question altogether. In (ii) numerous intelligent answers were seen and the oxidation of carbon-containing side-chains was understood. The less successful answers tended to think along the lines of alcohol or aldehyde oxidation, and again ignored the molecular formula.

Phosphorus pentachloride was known by virtually everyone for (e)(i). There were many carefully-drawn repeating units of PET in (ii), but a significant minority did not realise that the **repeating** unit was wanted, and no more. Leaving aside some rather exotic ideas from a few, many candidates gave sensible suggestions for materials that should not be stored in a PET bottle. The significant minority who suggested water had presumably not realised what the principal function of such bottles is.

Hints for revision

- Paper 5 has significant synoptic content; practise relating the topics in this paper to others you have met before in other units.
- Practise drawing apparatus carefully, thinking of the function of each part and remembering that molecules don't know which way to go. The apparatus must be drawn carefully in section.
- Be clear what the command words are in a question, and tailor your answer to these. 'State' means exactly that; if asked what you **see**, you see for example bubbles, not a colourless gas. 'Explain' requires a deeper answer and will usually involve some underlying theory.
- Write calculations carefully so that anyone can understand what steps you are taking. Calculations need words, too. Be very careful to write numbers carefully, since examiners do not see whole scripts and have no opportunity to get used to your writing.
- Learn organic reactions thoroughly.
- In multi-step mechanisms it is better for each step to be shown completely separately, so that the product from the first step is then re-written for the start of the second.

6246/01 (Coursework)

General

This report should be read with the preceding 6243/01 one since all of the points relating to the administration of the scheme apply equally to 6246/01 and are not repeated here. Teachers new to the scheme are advised to read the sections relating to coursework in previous Examiners' Reports

Almost all centres now use exclusively the Edexcel exercises from the Internal Assessment of Practical Coursework Issue 2 (August 2003) booklet.

Administration

In addition to the points made in the preceding 8080 report centre assessors should take action on the following points as appropriate.

- The sample of work sent to the moderator should have each candidate's work collated with the completed record sheet as a cover.
- The front page for each exercise should be fully completed by the candidate.
- Ability B exercises must be accompanied by centre assessor's values.
- The mark for an organic exercise must be included in the total mark. This is a requirement of the scheme.
- The counting marks must be ringed on the record sheet.
- It is preferable not to send the sample of work in files or folders. Simply use a paperclip to keep each candidate's work together.

Comments on assessment of the abilities

Ability A Planning

Exercise A2.6 requires candidates to draw a diagram of both reflux and distillation apparatus. These diagrams are always likely to be included in a question in the written papers. It is well worth while encouraging candidates to practice the drawing of these diagrams.

Ability B Manipulation

Both of the redox titration exercises, A2.8 and A2.9, are straightforward and are able to be completed in one laboratory session. A useful teaching-assessment strategy is to use one of the exercises as a practice then the other as an assessment exercise. Candidates should be well rehearsed in the use of the balance, volumetric flask, pipette and burette before attempting the assessment exercise. They should be able to gain concordant titres-within a range 0.20 cm^3 .

Ability C Observing and recording

There are some assessors who award observation marks too generously. Unless a candidate's observation matches that in the mark scheme it should not receive a mark. Generally an inference mark should follow an appropriate observation. For example in A2.11, 1(c) the inference mark for the sulphate ion should only be awarded if a white precipitate has been observed and recorded. Candidates should

be taught to use the term “precipitate” when appropriate. Suspension, cloudiness or milky need never be used when a precipitate is obviously formed. It is accepted that in A2.13 some of the colours in the mark scheme are open to interpretation. If the centre assessor observes the colours obtained by the candidates then marking may follow the assessor’s own observations.

Ability D Interpretation and evaluation of experimental results

Following is a comment from two previous Examiners’ Reports explaining an error in the scheme that is still being missed by some centres.

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

Hints for carrying out coursework

- When you calculate a numerical value from your experimental results think about the number of significant figures that are appropriate. Generally three significant figures is enough for a value based on titration results. If temperature measurements are included in the exercise then two significant figures will usually be enough.
- When two solutions are mixed and a solid forms describe it as a precipitate. Don’t use the word suspension or cloudy or milky.
- When titrating one solution from a burette into another solution in a conical flask make sure that you continually swirl the flask. As you approach the end point add the solution from the burette one drop at a time.
- Read burette volumes to the nearest 0.05 cm^3 . Average consistent titres and record the average to the second decimal place or to the nearest 0.05 cm^3 .

6246/01A

General

A titration was included in the summer test for the first time this year. The volumetric solutions supplied to home centres gave consistent and reliable titres enabling the examiners to award marks for accuracy and concordancy by comparing a candidate's mean titre with that obtained by the examiners using identical solutions. The materials supplied for the qualitative tests also proved to be reliable giving the expected reactions at least for some candidates in every centre.

The Candidate Information included with the Instructions is the only information that may be divulged to candidates. It is a breach of the conditions relating to the conduct of the examination to issue candidates with "preparation sheets" based on a prior knowledge of the content of the examination paper.

Question 1

The thiosulphate-iodine titration proved to be a successful addition to the test. Candidates who recorded a mean titre within 0.20 cm^3 of the examiners' value and who had averaged titres within a range of 0.20 cm^3 gained high marks in (a). To gain the mark for Table 1 volumes had to be recorded to the nearest 0.05 cm^3 as did the mean titre.

The calculation in (b) was fairly demanding since it was not structured. The mole ratio of 1:6 for iodate to thiosulphate proved to be beyond many candidates but consequential marking made allowance for an incorrect ratio. The instruction to give the concentration of sodium thiosulphate to three significant figures was frequently ignored or perhaps misunderstood. It will benefit candidates for future examinations to be given practice in expressing answers to a set number of significant figures. If a candidate's titration results led to a calculated concentration of sodium thiosulphate of $0.1045 \text{ mol dm}^{-3}$ this should have been written as 0.105 not 0.11 mol dm^{-3} . Similarly a calculated concentration of $0.1003 \text{ mol dm}^{-3}$ should have written as $0.100 \text{ mol dm}^{-3}$.

Part (c) was well answered but (d) less so. In (d)(i) a colour change should have included both the colour before and after the end point. To score the mark in (d)(ii) it was essential to state that the end point is sharper or clearer with starch present.

Question 2

Compound C was copper(II) sulphate. Element D was iron. The tests in (a) to (c) generally gave the expected observations. As ever candidates need to be taught to gently shake test tubes to allow complete mixing of reagents otherwise precipitates are likely to fail to dissolve in excess. There were many examples of candidates failing to follow the detail in the question when writing inferences. The style of question in this paper has changed in the past few years. More guidance is now given to exactly what is required for an inference. For example in (c)(i) barium sulphate not the sulphate ion was needed to gain the inference mark.

In (b) the observation that the blue solution is decolourised was often missed. In (c)(ii) although the brown precipitate of iron(III) hydroxide was nearly always recorded the green iron(II) hydroxide precipitate was often omitted. Candidates should be told to record all the observations not just those at the end of the tests. To explain the reaction that occurs when the mixture stood for a few minutes it was necessary to refer to the oxidation by oxygen or air.

Question 3

Compound E was ethanol.

Almost all candidates correctly noted the colour change from orange to green in (a). Since candidates had been told that E was an alcohol inferences that included aldehydes were not awarded a mark. If no yellow precipitate was observed in (b) then credit was given for inferences that stated that “a methyl secondary alcohol or ethanol is not present.” If iodoform was observed then the three compounds drawn in (c) should have been ethanol, propan-2-ol and butan-2-ol. A very common error in (d)(i) was to write the name of a carbonyl compound listed in Table 2 rather than that of E, an alcohol. Most candidates scored the mark in (d)(ii) for suggesting that the derivative was impure or possibly damp.

Question 4

The planning question proved to be more demanding this year. Possibly because this was the first time that a plan to follow the rate of reaction had been set. For many candidates, often whole centres, the access to books and notes proved to be a major distraction. The examiners will never set a planning question that may be answered simply by copying a similar exercise from a book. Candidates need to be made aware of this fact. Many answers described a rates exercise, often using the same reagents as in the question, that involved taking samples, quenching then titrating the liberated iodine with sodium thiosulphate. The question, however, described a quite different method that involved mixing all the solutions together and observing the first appearance of the blue-black iodine-starch complex.

It was expected that Table 4 would be completed by changing the volumes of hydrogen peroxide and water so as to keep the total volume of solution at 50.0 cm³. The solutions should have been kept in a water bath at 20°C and timing started when either the potassium iodide or hydrogen peroxide was added to the other solutions. The starch should not have been added later. Timing should have stopped at the first appearance of a blue-black colour.

Hints for revision

- In observation-inference questions you must give the inferences asked for in the question not those that may have been asked in previous years.
- Make sure that you know how to give a number to a certain number of significant figures. For example 0.1056 to three significant figures is 0.106.
- When you make an inference make use of all the information given to you. If you have been told in a question that a compound is an alcohol and a test shows that it is oxidised by acidified dichromate your inference should be primary or secondary alcohol not aldehyde.

- You will not find the full answer to a planning question in a book or your notes. You will be asked to plan an experiment that may be similar to one you have carried out in your course but it is very unlikely that it will be identical. Read the planning question very carefully. There will be precise instructions as to what you should write. Follow these instructions in your answer.

6246/01B

General

A titration was included in the summer test for the first time this year. The volumetric solutions supplied to home centres gave consistent and reliable titres enabling the examiners to award marks for accuracy and concordancy by comparing a candidate's mean titre with that obtained by the examiners using identical solutions. The materials supplied for the qualitative tests also proved to be reliable giving the expected reactions at least for some candidates in every centre.

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The calculation in (b) was fairly demanding since it was not structured. The mole ratio of 1:6 for iodate to thiosulphate proved to be beyond many candidates but consequential marking made allowance for an incorrect ratio. The instruction to give the concentration of potassium iodate to three significant figures was frequently ignored or perhaps misunderstood. It will benefit candidates for future examinations to be given practice in expressing answers to a set number of significant figures. If a candidate's titration results led to a calculated concentration of potassium iodate of $0.01506 \text{ mol dm}^{-3}$ this should have been written as 0.0151 not $0.015 \text{ mol dm}^{-3}$. Similarly a calculated concentration of $0.01503 \text{ mol dm}^{-3}$ should have been written as $0.0150 \text{ mol dm}^{-3}$.

Part (c) was well answered but (d) less so. In (d)(i) a colour change should have included both the colour before and after the end point. To score the mark in (d)(ii) it was essential to state that the end point is sharper or clearer with starch present.

Question 2

Compound K was copper(II) sulphate. Element L was zinc. The tests in (a) to (c) generally gave the expected observations. As ever candidates need to be taught to gently shake test tubes to allow complete mixing of reagents otherwise precipitates are likely to fail to dissolve in excess. There were many examples of candidates failing to follow the detail in the question when writing inferences. The style of question in this paper has changed in the past few years. More guidance is now given to exactly what is required for an inference. For example in (c)(i) barium sulphate not the sulphate ion was needed to gain the inference mark.

In (b) the observation that the blue solution is decolourised was often missed. It was also expected that candidates would notice the reaction mixture becoming warm and infer that the reaction is exothermic. In (c)(ii) the white precipitate of

zinc hydroxide readily dissolved in excess ammonia to give the zinc complex ion in which zinc is bonded to four, not six, ammonia molecules. Even at this level it is obviously necessary to instruct candidates in the writing of correct ionic equations. In (d) there should have been no sulphate ions included.

Question 3

Compound **M** was propan-2-ol. Almost all candidates correctly noted the colour change from orange to green in (a). Since candidates had been told that **M** was an alcohol inferences that included aldehydes were not awarded a mark. Following the observation of a yellow precipitate in (b) the inference should have been that iodoform was formed and that “a methyl secondary alcohol or ethanol is present.” Following this inference the three compounds drawn in (c) should have been ethanol, propan-2-ol and butan-2-ol.

A very common error in (d)(i) was to write the name of a carbonyl compound listed in Table 2 rather than that of **M**, an alcohol. Most candidates scored the mark in (d)(ii) for suggesting that the derivative was impure or possibly damp.

Question 4

The planning question proved to be more demanding this year. Possibly because this was the first time that a plan to follow the rate of reaction had been set. For many candidates, often whole centres, the access to books and notes proved to be a major distraction. The examiners will never set a planning question that may be answered simply by copying a similar exercise from a book. Candidates need to be made aware of this fact. Many answers described a rates exercise, often using the same reagents as in the question, that involved taking samples, quenching then titrating the liberated iodine with sodium thiosulphate. The question, however, described a quite different method that involved mixing all the solutions together and observing the first appearance of the blue-black iodine-starch complex.

It was expected that Table 4 would be completed by changing the volumes of potassium iodide and water so as to keep the total volume of solution at 40.0 cm³. The solutions should have been kept in a water bath at 20°C and timing started when either the potassium iodide or iron(III) sulphate was added to the other solutions. The starch should not have been added later. Timing should have stopped at the first appearance of a blue-black colour.

Hints for revision

- Careful writing inferences. If you are asked to identify the white precipitate formed when barium chloride is added to a solution it is barium sulphate not the sulphate ion.
- Make sure that you know how to give a number to a certain number of significant figures. For example 0.01501 to three significant figures is 0.0150.
- To measure a solution accurately use a pipette or burette not a measuring cylinder. If the solution is in excess then its volume need not be measured precisely so a measuring cylinder will do.
- Iodine and starch form a compound with a blue-black colour not just blue or black.

6246/01C

General

A titration was included in the summer test for the first time this year. Centres prepared the volumetric solutions according to the instructions provided by Edexcel. In most centres the supervisor's mean titre agreed well with those of the candidates. For these centres the examiners awarded accuracy marks by comparing the candidate's mean titre with that of their supervisor.

The Candidate Information included with the Instructions is the only information that may be divulged to candidates. It is a breach of the conditions relating to the conduct of the examination to issue candidates with "preparation sheets" based on a prior knowledge of the content of the examination paper.

Question 1

The thiosulphate-iodine titration proved to be a successful addition to the test. Candidates who recorded a mean titre within 0.20 cm^3 of their supervisor's value and who had averaged titres within a range of 0.20 cm^3 gained high marks in part (a). To gain the mark for Table 1 volumes had to be recorded to the nearest 0.05 cm^3 as did the mean titre. The calculation in (b) was fairly demanding since it was not structured. The mole ratio of 1:5 for manganate(VII) to thiosulphate proved to be beyond many candidates but consequential marking made allowance for an incorrect ratio. The instruction to give the concentration of potassium manganate(VII) to three significant figures was frequently ignored or perhaps misunderstood. It will benefit candidates for future examinations to be given practice in expressing answers to a set number of significant figures. If a candidate's titration results led to a calculated concentration of potassium manganate(VII) of $0.01904 \text{ mol dm}^{-3}$ this should have been written as 0.0190 not $0.019 \text{ mol dm}^{-3}$. Similarly a calculated concentration of $0.01996 \text{ mol dm}^{-3}$ should have been written as 0.0200 and not 0.02 mol dm^{-3} .

Part (c) was well answered but (d) less so. In (d)(i) a colour change should have included both the colour before and after the end point. To score the mark in (d)(ii) it was essential to state that the end point is sharper or clearer with starch present.

Question 2

Compound R was aluminium chloride. Compound S was manganese(II) sulphate.

The expected inference in (a) following the observation of a red colour was that the cation in R had a high polarising power or a $3+$ charge. Following the observation of a white precipitate that dissolved in excess sodium hydroxide in (b) candidates were expected to infer that aluminium was the cation in R. When zinc or lead were also inferred as the cation these were ignored rather than penalised. In (c) many candidates ignored or failed to read the instruction to suggest the identity of the new species observed by giving the chloride ion rather than silver chloride as their inference. The most appropriate description of the precipitate of manganese(II) hydroxide observed in (e) is off-white. This turned brown on the addition of hydrogen peroxide.

Another example of candidates failing to follow the detail in the question when writing inferences was seen in (f). The style of question in this paper has changed in the past few years. More guidance is now given to exactly what is required for an

inference. Barium sulphate not the sulphate ion was needed to gain the inference mark. Candidates need to be taught to write the inferences demanded by the particular question and not to simply repeat those from past papers.

Question 3

Compound T was propan-2-ol.

Almost all candidates correctly noted the colour change from orange to green in (a). Since candidates had been told that T was an alcohol inferences that included aldehydes were not awarded a mark. Following the observation of a yellow precipitate in (b) the inference should have been that iodoform was formed and that “a methyl secondary alcohol or ethanol is present.” Following this inference the three compounds drawn in (c) should have been ethanol, propan-2-ol and butan-2-ol. A very common error in (d)(i) was to write the name of a carbonyl compound listed in Table 2 rather than that of M, an alcohol. To gain the mark for (d)(ii) candidates had to realise that the derivative was a solid so that recrystallisation and not distillation was a suitable technique.

Question 4

The planning question proved to be more demanding this year. Possibly because this was the first time that a plan to follow the rate of reaction had been set. For many candidates, often whole centres, the access to books and notes proved to be a major distraction. The examiners will never set a planning question that may be answered simply by copying a similar exercise from a book. Candidates need to be made aware of this fact. Many answers described a rates exercise, often using the same reagents as in the question, which involved taking samples, quenching then titrating the liberated iodine with sodium thiosulphate. The question, however, described a quite different method that involved mixing all the solutions together and observing the first appearance of the blue-black iodine-starch complex.

It was expected that Table 4 would be completed by changing the volumes of iron(II) sulphate and water so as to keep the total volume of solution at 50.0 cm³. The solutions should have been kept in a water bath at 20°C and timing started when either the potassium iodide or potassium persulphate was added to the other solutions. The starch should not have been added later. Timing should have stopped at the first appearance of a blue-black colour.

Hints for revision

- Careful writing inferences. If you are asked to identify the white precipitate formed when silver nitrate is added to a solution it is silver chloride not the chloride ion.
- Make sure that you know how to give a number to a certain number of significant figures. What are these concentrations to three significant figures? For example 0.01997 to three significant figures is 0.0200.
- Solutions containing +3 cations such as Al³⁺ will turn Universal Indicator red.
- Although you are allowed the use of books and notes in the practical test it is very unlikely that you will find an exact answer to the planning question in these. If you simply copy an experiment from a book it will not be awarded a high mark.

6246/02

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

Question 1

In (a) many candidates did not appreciate the importance of stating that lead sulphate was a solid and therefore does not appear in K_c for a heterogeneous equilibrium. Many candidates suggested that it being in excess was the explanation while others suggested that its mass could be calculated from the number of moles of the other reagents. Although many candidates got (b) right a surprising number of candidates gave equations which included NO_3^- or AgNO_3 .

The calculation proved difficult for many candidates but the main criticism was the lack of explanation by many. Many candidates simply wrote a mass of numbers without any clear explanation of what they were calculating. Where possible, consequential marks were awarded following one incorrect step, although this was sometimes difficult for the candidates who did not explain their working. Those candidates who did give an explanation of the steps often scored highly even though they may not have obtained the correct final answer. Common errors were: Failure to state the initial moles of I^- ; using the equilibrium moles of I^- to calculate the moles of sulphate rather than the difference between initial and equilibrium moles; failure to divide by 2 in calculating moles of sulphate; failure to convert moles to concentrations and to substitute moles rather than concentrations into K_c . Many candidates used incorrect volumes, commonly 81cm^3 , for the total volume.

Question 2

The majority of candidates were able to give correct acid-base conjugate pairs though weaker candidates mixed up the pairs or gave acids as bases and vice versa. The K_a expression was correctly stated by most candidates. The commonest error was to include the concentration of water. Some candidates incorrectly gave the approximated form using $[\text{H}^+]^2$ as the top line. A high proportion of candidates scored the two calculation marks but assumptions were less well stated. The assumption concerning $[\text{NH}_4^+]$ being equal to the initial $[\text{NH}_4\text{Cl}]$ was rarely given. Many candidates made general statements relating to HA, partial dissociation or weak acids without relating them to the question. A surprising number of candidates chose the wrong indicator. Although many expressed their answers well, clarity needed to be improved by use of the term $\text{p}K_{\text{in}}$. The realisation that this was a weak base/strong acid titration allowed many candidates to score the mark here. Although many good answers were seen, a surprisingly large number of candidates found it difficult to write an equation to explain the alkalinity of cyanide ions in aqueous solution. Equations which produced H^+ or H_3O^+ were commonly seen.

The mechanism for nucleophilic addition was better answered than in recent examinations, but many candidates repeated the errors of previous candidates: attack by HCN, protonation of carbonyl group, self-ionisation of carbonyl group. Candidates often lose marks by omission of charges on nucleophiles and intermediates.

The S_N2 mechanism was well done by the better candidates though it was common for candidates to omit the curly arrow breaking the C-Cl bond (or show it in the transition state). Common errors in drawing the transition state were to omit partial bonds and to show the bond to the nitrile group attaching through the nitrogen atom.

The question concerning pH control in nucleophilic addition has been asked several times recently but the majority of candidates give incorrect answers or answers too vague to be credited. Many candidates understood why control of pH was important but did not express themselves clearly. For example candidates referred to displacement of the equilibrium to form HCN or CN⁻ without explaining the effects on the reaction.

Question 3

The majority of candidates correctly defined the enthalpy of formation though many actually defined the standard enthalpy change. Omission of references to standard states of the elements was common. Some candidates referred to ionic solids or gaseous atoms or ions showing confusion with other enthalpy changes. Most candidates were able to correctly calculate the two enthalpy changes in (b) and many explained their working clearly. Incorrect use of signs was the most common error. Most candidates realised that the most exothermic reaction was most likely thermodynamically. However, although many candidates scored the mark for stating that a catalyst provided an alternative route with lower activation energy many candidates tried to explain the greater effect on reaction I by relating it to the thermodynamic stabilities. Other candidates tried to explain the effect by referring to the number of molecules involved. Specificity of catalysts was rarely recognised. A significant number of answers made reference to a catalyst changing the ΔH value as a result of a lower E_a , showing a lack of understanding.

Most candidates could explain the role of sulphuric acid in formation of the nitronium ion and give relevant equations. Marks were often lost owing to omission of charges in the equations, or incorrect charges such as NO₂⁻. The number of candidates who suggested that nitric acid was the stronger acid was most surprising. Candidates choosing sulphuric acid frequently cited incorrect reasons such as having two protons to donate or being more fully dissociated than nitric acid. The term “deprotonates” was commonly seen in place of the correct “protonates”.

Many candidates scored full marks for the mechanism in (d)(iii). The most common errors were drawing curly arrows starting or finishing at the wrong places, putting too many or no charge on the intermediate ion. The partial circle was often very poorly drawn and many candidates do not seem to understand what it represents. In explaining the reasons why benzene undergoes substitution many scored the first delocalised electron mark, but quite even good candidates referred to ‘delocalised bonds’ or ‘pi delocalisation’ with no mention that it involved electrons. Good clear explanations were easy to award full marks but lack of clarity involved a poor comparison between substitution and addition or not mentioning one mechanism at all. Many stated that ‘it would be more stable to undergo substitution’ or ‘would be more energetically favourable without explaining why’. The strongest candidates brought in activation energies and an attempt at comparing these was made. This is a standard question and candidates need to practise writing precise explanations.

Most candidates recognised that further nitration would occur and gave correct formulae for dinitrobenzene or trinitrobenzene. In choosing reagents for oxidation of the side chain to a carboxyl group most candidates were aware of alkaline potassium manganate(VII) but weaker candidates referred to acidified permanganate (VII) or even acidified dichromate. Only the better candidates realised that a second, acidification stage was then necessary.

Question 4

Correct electronic configurations for copper and its ion were almost universally correct but candidates gave very poor explanations for the lack of colour. Particularly common was the use of the singular orbital instead of orbitals or sub-shell. Many candidates stated that d splitting could not occur and many stated that electron promotion was impossible without making it clear that it was promotion within the d-subshell. Weaker candidates commonly argued that, as it has no unpaired d electrons, Cu^+ is not a transition metal ion.

Most candidates could derive a correct equation for disproportionation and calculate a correct E_{cell} value but a significant number failed to balance their equations by not having 2Cu^+ . A few equations were the wrong way round, indicating that candidates just used the data, rather than understanding what they were doing. Only the better candidates realised the importance of kinetic barriers to reaction and many answers referred to the size of the E_{cell} value, the fact that the reaction was an equilibrium and in a few cases to non-standard conditions. As in previous examinations, many answers showed great confusion between the concepts of kinetic and thermodynamic stability.

The great majority of candidates obtained a correct empirical formula but some were obviously put off by its unfamiliarity and could not do the next part or made a half-hearted effort without all the elements. Even with the sulphate test being obvious, about 30% of answers had no sulphate in them. The cuprammonium ion was very poorly answered. The most common errors were to state Cu^{2+} or $[\text{Cu}(\text{NH}_3)_6]^{2+}$. Quite a few answers were not ions! Almost all candidates recognised this as a ligand exchange reaction.

Most candidates are clearly not familiar with the use of derivatives to identify carbonyl compounds. Nearly all students got the first mark for obtaining 2,4-dinitrophenylhydrazone precipitate but then did aldehyde/ketone tests with Fehling's etc. A major and very common misconception was to use mass/IR/NMR spectrometer on the original carbonyls or to do melting or boiling temperature determinations on them and compare values with data book. Of candidates using the correct approach recrystallisation was often omitted. A few did boiling temperature tests instead. There was also lack of clarity with which product candidates were referring to - product of the reaction or the 2,4-DNP derivative.

The further oxidation product was very commonly identified only as a carboxylic acid rather than the specific answer required - propanoic acid. Candidates were not sufficiently precise in stating that to prevent further oxidation the product needed to be distilled off "as it is formed".

The role of copper as a catalyst but not as a provider of oxygen was not understood. References to copper as a (poor) oxidising agent were quite common.

Few candidates could give a clear explanation that of the role of active sites and that catalysis depends on unoccupied active sites being available. Vague discussion of collision theory was the best that many candidates could come up with.

Hints for Revision

- Practise all types of moles calculations and set out answers clearly to show every step of your working.
- Learn all the functional groups in the organic chemistry part of the specification.
- Revise all topics from AS Chemistry for this examination as well as the A2 topics.
- Learn the main mechanisms of the specification and be precise about the origin and tip of curly arrows. Take great care to account for all charges at all stages in a mechanism. Learn to be precise about the structure of intermediates and transition states.
- Practise writing definitions and explanations with precise use of scientific terminology.
- Learn the correct use of the terms orbital, sub-shell and shell in describing atomic structure and in explaining electron transitions.
- When writing formulae and equations, write numbers clearly ;always check charges are correct

Appendix A: Statistics

6241/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	44	38	32	27	22
Uniform boundary mark	90	72	63	54	45	36

6242/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	45	39	33	28	23
Uniform boundary mark	90	72	63	54	45	36

6243/01 cwk + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	79	71	64	57	50
Uniform boundary mark	120	96	84	72	60	48

6243/01A + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	70	63	56	49	42
Uniform boundary mark	120	96	84	72	60	48

6243/01B + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	71	63	56	49	42
Uniform boundary mark	120	96	84	72	60	48

6243/01C + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	71	63	56	49	42
Uniform boundary mark	120	96	84	72	60	48

6243/01T tcwk+ 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	79	71	64	57	50
Uniform boundary mark	120	96	84	72	60	48

6244/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	58	51	45	39	33
Uniform boundary mark	90	72	63	54	45	36

6245/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	51	45	40	35	30
Uniform boundary mark	90	72	63	54	45	36

6246/01 cwk + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	79	72	66	60	54
Uniform boundary mark	120	96	84	72	60	48

6246/01A + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	68	60	52	45	38
Uniform boundary mark	120	96	84	72	60	48

6246/01B + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	69	61	53	45	38
Uniform boundary mark	120	96	84	72	60	48

6246/01C + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	67	59	51	44	37
Uniform boundary mark	120	96	84	72	60	48

6246/01T tcwk + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	79	72	66	60	54
Uniform boundary mark	120	96	84	72	60	48

Notes

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

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

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