

Examiners' Report January 2007

GCE

GCE Chemistry (8080/9080) [International]

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Unit 6241/01

General

The January 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. While this paper proved to be accessible to a wide range of candidates offering opportunities to show an understanding of basic work, it also required a clear understanding of key concepts and an ability to construct a logical and precise argument. There were some outstanding answers to individual questions and some near flawless scripts but some candidates had clearly not yet mastered the minimum standard required for AS Chemistry. There were no 'dead marks' on the paper. There was an overall improvement in the use of technical vocabulary but there remain candidates who do not appreciate the necessity for precision in their choice of words. There are a significant number of candidates who were unable to write balanced equations for chemical reactions and many more were unable to write correct half ionic equations.

Question 1

In (a) and (b) almost all candidates were able to determine the numbers of sub-atomic particles in the isotopes of magnesium and to write the required electronic structures. The equation in (c) caused difficulties: some were unable to write the required formulae of molecular chlorine and magnesium chloride and many failed to complete the states correctly, with aqueous magnesium chloride being a common error even when the states of the reactants were correct. In (d) the majority of candidates used the data to calculate the A_r of chlorine, taking average values for the isotopic masses or, on a few occasions, using the data correctly and then dividing their final answer by 2. The volume calculation in (e) posed little difficulties to the better candidates but it was quite common for candidates to use A_r even when M_r had been correctly calculated, and units were often omitted or incorrect. There were many fully correct responses to (f) although there were still some candidates who described the structure of magnesium but not the bonding. While there were many excellent dot and cross diagrams in (g) some candidates simply showed how the electrons would move without giving the required completed structures. Covalent bonding diagrams were common, even when candidates had correctly identified the bonding type.

Question 2

The definitions in (a) were well known but candidates frequently lost marks by omitting mention of the atom or nucleus; some assumed that the proton number and number of electrons were synonymous. Most candidates could identify the required elements in (b) (i) and (b) (ii) but few candidates were able to give clear explanations for their choice, commonly neglecting to include a reference to the ionisation energies in a specific period or just writing in general terms about periodic trends and group 3 elements. A significant number of candidates sought to explain the ionisation energies in terms of stable electronic configurations (filled shells and s orbitals). The trend in ionisation energies required in (b) (iii) was much better understood and many candidates demonstrated a clear understanding of the factors involved.

Question 3

The equations required in (a) showed that a significant number of candidates were unable to write formulae correctly or to balance equations. The flame colours of barium and lithium were well-known although reversing the colours was quite common. There were many excellent explanations of the flame colours with candidates across the range demonstrating a good understanding of this phenomenon. Common errors included the idea that the element or compound was excited rather than the electron and failure to state clearly that the energy was emitted as electromagnetic radiation (or light). Some candidates referred to the relaxation process as occurring 'on cooling'. A number of candidates simply described the procedure for carrying out the flame test. The calculation in (d) was completed confidently by most candidates. There were some excellent descriptions and diagrams of orbital overlap leading to σ and π bonding although a number of candidates simply described the bonds themselves and it was quite common to describe the π bond as a 'double bond' or to draw diagrams which contradicted the explanation. Weaker candidates seemed unfamiliar with orbitals and the concept of orbital overlap

Question 4

A significant number of candidates across the scoring range did not attempt (a) (i) but most who did correctly identified the ions in the lattice. Most candidates correctly explained the high melting point of sodium chloride although there remain candidates who use the terms atom, ion and molecule interchangeably or refer to sodium chloride having covalent bonding and intermolecular forces, often in addition to ionic bonds. Most candidates were able to identify the covalent bonds in graphite and diamond for (b) and (c) but the nature of the forces between the layers in graphite was less well understood and hydrogen bonds, metallic bonds and 'delocalised electrons' were common suggestions; some candidates referred to a 'giant covalent bond'. Few candidates could suggest a clear explanation for the differences in density of graphite and diamond. Many simply reiterated the differences in bonding or mentioned the different numbers of covalent bonds while others discussed the hardness or electrical conductivity of the allotropes.

Question 5

In (a) most candidates knew that strongest intermolecular force in hydrogen fluoride is hydrogen bonding and the majority of these could identify the strongest intermolecular force in the other hydrogen halides although some believed the permanent dipole interactions would be stronger than the dispersion forces. There were many explanations of the boiling point trend in (b) but these were frequently marred by imprecise use of vocabulary with frequent references to ions, charge density and covalent bonds.

Question 6

The ionic half equation required in (a) (i) proved to be very challenging. Many candidates were unable to balance the material or the charges and the electrons were commonly added to the right-hand side of the equation. Part (a) (ii) was attempted with greater success, reflecting its greater simplicity and familiarity, but even here the electrons often appeared on the wrong side of the equation and chlorine atoms were quite common. The overall equation in (b) was frequently correct even when the ionic half equations were not although some candidates did include electrons. Most candidates were able to write the correct equation for (c) although some ignored the requirement (in bold) for the equation to be ionic. The calculation in (c) was successfully completed by most candidates although premature rounding was an issue for some candidates.

Hints for revision

- Ensure that you clearly understand the terms atom, ion, molecule and charge density.
- Check that you understand that the term 'giant' refers to structural types not bonds.
- Set out calculations clearly, showing each step and rounding only on the final answer.
- Practise writing ionic half equations

Unit 6242/01

General

The paper had questions which were accessible to candidates of all abilities. There were some high-scoring scripts, but also some with low scores where candidates did not know the factual content and could not explain the concepts.

There were some questions that candidates had not met before where they had to suggest a reason for the information they were given. Some candidates did not score marks for these because their quality of written communication was poor and the examiner could not understand the point they were making.

The points made about writing in colour, particularly red, that have been made in previous reports, still apply. Candidates should also be encouraged to write all of their answers in the question booklet provided, using the space underneath questions or the blank pages if necessary, and make a clear reference to where the question has been answered. They should only be given separate writing paper if there is no space left in the question booklet.

Question 1

This was intended to be a straightforward question on organic chemistry, with many short answer items. The majority of candidates gave excellent answers to these items but there were a few who did not know how to draw the structural formulae as they did not know how many carbon atoms there are in pentane or propane. Some candidates lost marks by drawing careless structures, for example, drawing a bond between a carbon atom and the H of the OH group in the alcohol, or drawing carbon skeletons with no hydrogen atoms.

Many candidates knew that the geometric isomers were the cis and trans structures of pent-2-ene, but quite a few drew the structural isomers of pent-2-ene. Quite a few candidates did not know the structure of pent-2-ene.

A lot of candidates could classify all three reagents in (c), with many giving the type of reaction as well, even though this was not required. Some candidates gave more than one type of reagent, for example, oxidising agent and electrophile, so did not score the mark.

Question 2

Many candidates scored full marks for the definition of standard enthalpy of formation and all candidates are advised to learn the definitions carefully so they do not lose marks for these straightforward items. Common errors included: energy required instead of change, omitting standard states and mentioning standard conditions without specifying what those are.

The calculation of the standard enthalpy of formation of ammonia was done quite well by many candidates, but only the most observant scored the full 4 marks. Many used the bond enthalpies correctly and stopped when they got a value of -93 kJ. They forgot the definition they had just written was the formation of 1 mole of a compound and gave the value for 2 moles of ammonia. Quite a lot of candidates thought there were only 2 or 3 N-H bonds broken and many got confused and thought that energy was needed to form bonds and was given out when bonds are broken. The enthalpy level diagram was usually well drawn and was marked consequentially on their answer to the calculation. A surprising number of candidates who got a positive value in (i) drew an exothermic diagram in (ii). If they knew the Haber Process involves an exothermic reaction, they should have gone back and checked their calculation again. Many candidates knew a suitable temperature for the Haber Process and could explain it in terms of the rate of reaction. Fewer gave good explanations of the position of equilibrium, just stating 'the reverse reaction is favoured by a low temperature' rather than stating what happens to the yield of ammonia and why.

The majority of candidates knew the catalyst used and that it has no effect on the equilibrium yield of ammonia. Very few candidates answered (v) correctly. Most gave the rote answer and explained how catalysts work in any reaction by providing an alternative route with lower activation energy, and ignored the words 'in this process' at the end of the question. The good candidates who read the question carefully and used their answer to (iii), gave excellent explanations in terms of the temperature needing to be much higher for a reasonable rate without a catalyst but this would reduce the yield.

The majority of candidates could explain the effect of increasing the pressure on the equilibrium yield of ammonia. Some candidates just focused on the effect of increasing pressure on the rate of reaction, although this will be insignificant. Many candidates could not give a specific disadvantage of using 1000 atmospheres pressure. Many just stated that it would be more expensive, rather than suggesting a particular expense.

Question 3

This question clearly distinguished between the candidates who had learnt the reagents and conditions for the reactions in the specification and those who just guessed any reagent they could think of. Some candidates who knew that sodium hydroxide was needed for the elimination reaction in Step 1, thought that it was in aqueous solution, as in a hydrolysis reaction.

Question 4

Very few candidates scored two marks for the identity of the electrolyte, the common errors were: bauxite instead of aluminium oxide, omitting the fact that cryolite is molten and that the alumina is dissolved in the cryolite.

The majority of candidates could write the ionic half-equation for the reaction at the cathode, even though a few did not know the charge on the aluminium ion, several made 3Al from Al^{3+} and quite a few lost the mark by using (aq) as a state symbol for the aluminium ion. Almost all candidates knew the electrodes are made from carbon.

Although (d) asks for an equation, an appreciable number of candidates just wrote a sentence to explain what happens to the anodes.

There were some excellent, clearly set out answers to the calculation in (e). The majority of candidates used moles, although reacting masses was equally acceptable. The most common error was not realising there are two aluminium ions in aluminium oxide, even though they were given its formula in the question. Some candidates divided the mass of aluminium by the molar mass of aluminium oxide but then could not proceed any further. Quite a few candidates did not know where to start this calculation.

The answers to both parts of (f) were answered badly by a large number of candidates and showed that although they knew some of the basic facts related to the manufacture of aluminium, they did not understand the process and could not apply their knowledge.

Most candidates ignored their answer to (a) when they answered (f), as energy is needed to keep the electrolyte molten. The suggestions in (f)(ii) were often poor and not expressed clearly. Some candidates think that electrolysis is still needed when aluminium is recycled and quite a few gave reasons about why it is recycled and not related to the reduction in energy. Quite a few candidates compared the melting point of aluminium with bauxite or aluminium oxide, even though these are not melted in the manufacture using electrolysis.

Question 5

The equation in (a)(i) was often completed correctly, although it was not unusual to see H_2 as a product, while that in (ii) frequently had $C_2H_4Br_2$ as the product. Candidates should not use a molecular formula when there is more than one possible structure that can be drawn from it; in this case they had to show that 1,2-dibromoethane is produced, rather than 1,1-dibromoethane.

Many candidates showed a clear understanding of the difference in reactivity of ethane and ethene in terms of the bonds broken. A significant number did think that a C-C bond was broken in ethene and many included σ and π bonds broken in ethene. A few candidates included intermolecular forces.

Question 6

The drawing of the Maxwell-Boltzmann distribution of molecular energies is still causing many candidates problems, although this has been asked on several past questions. Candidates should practise drawing these curves until they can sketch them with reasonable accuracy. Far too many curves leveled off too high above the x-axis and some even started to curve upwards at the end. The axes were often not labelled or were wrongly labelled. Some candidates labelled the activation energy line correctly, but labelled the x-axis as temperature or time.

The question in (b) asked candidates to explain why temperature increases the rate of reaction in terms of the frequency and energy of collisions and to use their answer to (a). Many candidates completely ignored this and wrote an answer they had learnt from a previous paper. A number of candidates did not seem to understand the meaning of frequency. Many candidates shaded the area after the activation energy line on their graphs, but did not label it or refer to it in their explanations. A surprising number of candidates thought that the frequency of collisions was more important than the energy of collisions.

Question 7

Most candidates could identify the functional group in compound W, but a lot of them thought that it was a primary alcohol as they did not use the information that it did not react with acidified potassium dichromate(VI). Compound Y was identified correctly by many candidates, but those who gave butan-1-ol as their answer to (ii) did not score a mark for butanoic acid as Y had to be produced from an isomer of W. Many candidates were familiar with Markovnikoff's rule and gained full marks for (b).

Hints for revision

- Practise drawing organic structures carefully and learn the number of carbon atoms in each alkane.
- Learn definitions carefully.
- Practise bond enthalpy calculations.
- Learn the reagents and conditions needed for all of the organic chemistry reactions in the specification.
- Practise drawing the Maxwell-Boltzmann distribution of molecular energies until you can draw it accurately.
- When a piece of extended writing is required, explain your points clearly and fully so that the examiner can understand them.
- Read the questions carefully and refer to every part of the question in your answer.

6243/01(Coursework)

General

Almost all of the centres entering candidates for this session had previously submitted samples of work to the moderator. Many of these had noted the comments on the E9 feedback form and taken remedial action where necessary. Previous Examiners' Reports are a source of advice and tips on the administration and implementation of the scheme. For these reasons this report is deliberately brief. Teachers new to the scheme would do well to read the 2005 and 2006 Examiners' Reports. If a centre has received an E9 with no critical comments then the scheme is being operated correctly and candidates are being properly assessed.

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 2005 Examiners' Report is available on the Edexcel website under Chemistry GCE. The AS record sheet is on page 36.
- There is absolutely no need to send work in the sample, the mark for which has not counted towards to a candidate's final mark. Such work will not be looked at by the moderator.
- There is no requirement at all for candidates to word-process their work. Plans are sometimes submitted in word-processed form. When a moderator notices this, he or she assumes that the plan has been completed under supervision. If there is evidence that the conditions of the scheme have not been implemented properly then marks are likely to be reduced.
- The mark for an organic exercise should be included in the mark profile for every candidate.

Comments on the assessment exercises.

Very few centres submitted their own designed exercises in this session. The most popular Edexcel exercises are listed below. Any centre new to the scheme or wishing to change the range of exercises carried out may be assured that these are well-tried and tested. They will give able candidates with the full range of laboratory skills a fair chance to gain a high mark for their assessment component in the 8080 Chemistry award.

Ability A	Planning	AS3, AS5 and AS11.
Ability B	Manipulation	AS1, AS6 and AS7
Ability C	Observation and recording	AS9, AS12.
Ability D	Interpretation and evaluation	AS1, AS6, AS9, AS12

There are a number of routine practical skills that may not be implicitly included in the assessment exercises but which candidates should be able to implement. These include

- reading a burette to the nearest 0.05 cm^3 ,
- gently shaking a test tube as reagents are added,
- adding just a few drops of indicator in a titration,

rounding off numerical answers correctly and to an appropriate number of significant figures,

Summary

As ever almost all candidates were correctly and fairly assessed. Few centres had their marks altered. The moderators do appreciate the fact that centre assessors continue to administer the Edexcel scheme rigorously and in the correct spirit.

Hints for revision

- In a titration add just 3 or 4 drops of indicator to the solution in the conical flask.
- Be prepared to regard your first titre as a trial. You may wish not to include it in your mean.
- An enthalpy change has units of kJ mol^{-1} and will normally be rounded off to two significant figures if it is calculated from your own laboratory results.
- If you wish to refer to a book in the assessment exercises (not allowed in planning exercises) make sure that it is one that relates to the Edexcel specification.

Unit 6243/01A (Practical Test)

General

All the tests and exercises gave the expected results for at least some candidates in every centre.

It remains vital that supervisors in international centres prepare the materials carefully and carry out the quantitative exercises under the same conditions and using the same apparatus as the candidates. In a few international centres the supervisor's values for the titre and the temperature change differed quite widely from those of most of the centre's candidates.

Question 1

Compound **A** was potassium iodide.

The expected lilac flame in (a) was observed and recorded by most candidates. Although most candidates correctly recorded a yellow precipitate in (b)(i) many failed to score the inference mark. They wrote Ag^+ when the question asked for the identity of the precipitate. The expected explanation for the brown solution observed in (b)(ii) was that a redox reaction had taken place in which chlorine oxidised iodide ions to form iodine.

Question 2

The acid-carbonate titration was straightforward and carried out to a pleasing standard by the majority of candidates with most scoring high marks for the accuracy of their mean titre and for their narrow range of titres. It is expected that burette volumes will be recorded to the nearest 0.05 cm^3 and that the mean titre will be rounded off to the second decimal point or to the nearest 0.05 cm^3 . Parts (b)(i) to (v) of the calculations were straightforward and completed correctly by the majority of candidates. Although one mole of hydrated sodium carbonate normally has 10 moles of water of crystallisation the expected answer in (v) was one mole of water. Candidates should not always assume that the answer to a practical test question is identical to that in a book that may be available during the test.

Question 3

If candidates followed the procedure carefully they recorded the temperature rise expected based on the mass of anhydrous sodium carbonate used. Once the sodium carbonate had been used up effervescence stopped.

The amount of sodium carbonate was generally correctly calculated in (b)(i). In (ii) the heat change was accepted in either J or kJ but the units had to be included with the answer for the award of a mark. The expected units in (iii) were kJ mol^{-1} . The only accepted sign was a negative one since the reaction was obviously exothermic. Since the question clearly stated that the answer had to be given to two significant figures only answers such as -31 kJ mol^{-1} were accepted.

Question 4

In (a) of the planning question most answers included hydrochloric acid and barium chloride as reagents in the test. Many candidates failed to make clear that the barium chloride must be an aqueous solution. Hydrochloric acid should have been represented as HCl(aq) and not just HCl . To gain all three marks an answer had to include an observation that all the carbonate, either in the original solution or as barium carbonate, had been destroyed by the hydrochloric acid. The expected observation was that acid would be added to the solution until there was no more effervescence.

The expected procedure in (b) was to heat the mixture until there was no further loss on mass. The solid would have to be allowed to cool between heating and weighing.

Sodium hydrogencarbonate is converted to sodium carbonate by heat. This occurs in the solid state so there was no need to dissolve the mixture in water before heating.

Hints for revision

- Read the question very carefully when inferences are asked for. The expected response may not be the same as that in an equivalent question set previously.
- Always record burette volumes to the nearest 0.05 cm³ eg 24.50 cm³, not 24.5 cm³.
- Take care when rounding off numerical answers, 24.276 rounds off to 24.28 not 24.27.
- The units of heat in chemistry experiments are J or kJ. The units of an enthalpy change are kJ mol⁻¹.
- Sodium hydrogencarbonate is decomposed by heat in the solid state. There is no need to dissolve it in water before heating it to change it into sodium carbonate.

Unit 6243/02

Introduction

The paper covered much of the usual ground with candidates being given the chance to demonstrate skills involving analysis, calculation, and comment and planning. Many candidates showed excellent knowledge of analytical chemistry and the improvement in calculations seems to be continuing. However, scripts continue to show some deterioration in the general quality of written communication with many candidates unable to express themselves in a clear and concise manner. Many candidates are still choosing not to read the question carefully or ignore information or hints given in questions and are consequently failing to score marks. There is some evidence of lack of chemical common sense when answers that are clearly wrong are left.

Question 1

Most candidates scored well on (a) (d) and (e) of this question. Part (b) was generally poorly done with many answers omitting the nitric acid. Some candidates included the addition of ammonia at this stage, this was not penalised. In (c) most candidates were able to identify the gas (SO_2) but fewer were then able to go on and link this to the correct anion. Careless errors in (c) included SO_3^- and SO_4^{2-} . In (e) a majority were able to recall the test for chlorine but some produced incorrect colour changes for litmus or described the colour of the gas.

Question 2

This question, which asked candidates to suggest an analysis scheme to distinguish between two isomers, was poorly done by many candidates. The most common mark awarded was 2 out of 4 with these awarded for the identification of the unsaturated alcohol generally using bromine water. Candidates need to understand that the examiners are looking for precise use of chemical terminology in answers and will penalise poor use. This was often seen in the identification of Q where 'bromine' was quoted as the reagent rather than 'bromine water' or 'bromine solution'. Incorrect tests suggested for the identification of P included litmus but with wrong colour changes, phosphorus pentachloride, which would give a positive result for both P and Q, and acidified dichromate(VI) solution, which would be positive for Q but not P. Many candidates described the preparation of the acid rather than the identification test.

Question 3

The answers to this question showed that many candidates have a clear grasp of the chemistry of Group 2 and Group 7 with clear and concise answers being common. However, the identification of Z, MgI_2 , presented problems for some candidates. Wrong inferences included Mg^+ , Ba^{2+} , and those where candidates chose to ignore the information that Z was a salt of a group 2 metal and suggested sodium. The anion test often showed a lack of understanding of the chemistry of iodine and some candidates ignoring the black precipitate and identifying the anion as bromide. Nitrate was a common error. The formula was generally well done by those who had identified the ions present and even by those who had the wrong charge on the magnesium. But many able candidates gave away a mark by writing the name when the formula was asked. The question twice says that the formula is to be written. It is not clear what can be done about this other than to go on reminding candidates to read the questions carefully. Those candidates who made the correct inference, that the cation could not be calcium, strontium or barium, then went on to suggest a possible formula for Z scored full marks.

Question 4

Candidates would be well advised in questions of this type to spend a few minutes making sure they understand the information given concerning the preparation described.

In (a) (i) only the best candidates scored the full three marks. The question asks how the reflux apparatus **works** and **why it is necessary** for the preparation described. The condensation mark was usually obtained, although some failed to say that it was the gas/vapour produced which was condensed. The loss of volatile material mark was often scored, but the slow reaction mark was less often obtained. Many candidates found it difficult to put into words what they clearly understood. Some candidates described the apparatus rather than the way it works or referred to it as a closed system rather than one where reactants and products are recycled. There was lack of a clear understanding of why it is necessary to prevent the volatile reactants from leaving the reaction mixture and of the reason why the mixture needed prolonged heating. There was confusion over reflux and fractional distillation.

The general standard of drawing has showed some improvement but is still poor in many cases. Examiners were not looking for works of art but they were particularly looking for the correct positioning of the thermometer in the neck of the still head, a correctly indicated direction of the flow of water in the condenser and a system closed at the top of the flask/still head and open to the atmosphere at the collection end of the apparatus, as well as the general set up of the equipment. There were many examples of carefully drawn diagrams that showed clear understanding of the principles involved in the apparatus set up.

This was a generic question about heating flammable liquids safely and any indirect method of heating was allowed. Safety questions always assume candidates will wear safety goggles and protective clothing if this is deemed necessary by the risk assessment for the exercise.

Question 5

In (a) the majority of candidates scored the mark for the colour change with the only common error being to reverse the colour change. Almost all candidates were able to suggest a reason why the suggested titres should be chosen. Wrong answers included; the first titre was inaccurate; the first titre was wrong; the end point was missed. Almost all candidates scored the mark in (c) but there were just a few who averaged all three or the final burette readings.

The calculation, (c), was well done with many candidates scoring the full 4 marks. The layout was designed to help the candidate through the steps involved but some scored the first two marks and then subtracted rather than divided and left the final part. There seems to be a small but growing tendency in questions of this type of a failure to check calculations carried out on a calculator to ensure the data had been correctly entered or to miss copy data from one line of a calculation to the next. This resulted in some odd numbers appearing in (iii) which then became the correct answer, 2, in (iv). It is to be hoped that candidates will exercise common sense and if a calculation produces a number such as 1.68 for what is a simple ratio they should consider the possibility that they have made a mistake in the calculation and go back and check. In this case candidates were told in the question the formula of the acid and could have worked out what the reacting ratio was.

The calculation in (d) was set up so that those who had struggled with (c) could make a fresh start. In cases where the answer is given and the question requires the use of data to prove a point it is vital that **the way the data is used** is totally clear. A large number of candidates scored the full 4 marks for clear and well laid out calculations that showed how the data was used. Candidates should not be afraid to add words to their numbers if it explains where the data comes from. Some candidates only scored the first two marks because they did not show **how** the molecular mass data was used to convert the empirical formula to the molecular formula. Many candidates chose to answer the question using alternative routes. These were all allowed provided the chemistry

was sound. A common error seen several times was to round 2.67:4:4 to 1:2:2.

Drawing the structural formula in (d) proved a very good discriminator. Only those who had understood the rest of the question were able to draw a satisfactory structure. Some did not use the correct molecular formula ($C_4H_6O_6$), with many only containing 2 or 4 oxygen atoms. There were answers ignoring valency rules with monovalent oxygen and pentavalent carbon being common. Also many otherwise correct structures lost the mark because they showed a C-HO bond rather than C-OH.

Part (g) asked candidates to think about experimental method. The best candidates used the data to score both marks. Many others realised that the percentage error would be bigger for a smaller titre. Some candidates ignored the data given and adopted an approach based on the difficulty of carrying out the titration if the reading were only between 5 and 10 cm^3 and suggested that if the titre was in the 5 – 10 range it would be reached so quickly that the end point would be missed (an error in technique rather than experimental design). Some missed the point totally and suggested that if the reading was between 20 and 30 cm^3 the indicator would not change colour between 5 and 10 cm^3 .

Question 6

Many candidates scored full marks in (a) with clear, well laid out answers. However, a significant number used wrong mass data in the $ms\Delta T$ equation. Many using 4, 100 or 108 for the mass of solution instead of 104. It was not clear why this was done as the data was given in the question. Common errors included use of the wrong molecular mass for aluminium chloride and the omission of the sign in the final answer. A significant number of candidates do not seem to understand the difference between temperature change and enthalpy change and many answers were seen where the second part of (i) appeared in (ii) and nothing more was done. This was ignored in the marking with the score awarded wherever it appeared on the page. This sometimes led to wrong units with $kJ\ mol^{-1}$ instead of kJ being common.

In (b) examiners were looking for answers that addressed the issue of how the technique described could be modified to produce a better measurement of the temperature change. Most realised the need to monitor the temperature before and after the addition of the aluminium chloride but few could explain clearly how the graph produced from the results generated would be used. Some candidates suggested adding the solid a little at a time would produce greater accuracy and it was also suggested that the clock could be used to measure the temperature. Many said that readings of the temperature should be taken at regular time intervals “until the maximum temperature was reached”, thus showing a complete lack of appreciation of the cooling effect. Others described correct detailed methods but failed to add the solid. Those who failed to score went for insulation or failed to take a series of readings.

Most knew that a graph was involved. Some candidates draw a sketch graph of the expected results to help express their ideas more clearly but some confused this graph with that for the heat of neutralisation as they stated that the two lines, one increasing and one decreasing, would be extrapolated to the point where they crossed. Others who appreciated what was required failed to make it clear that the extrapolation is done to find the maximum temperature **at the point of adding the $AlCl_3$** .

Question 7

Only the very best candidates score the full 6 marks on this question. The best answers were those where candidates suggested an actual mass of solid sodium hydrogencarbonate, heated it and calculated the mass loss or produced for each of the possible reactions. The major error among those who clearly understood what was required was to not make it clear why the solid was being heated to constant mass.

As in previous years many candidates seemed not to have read the detail of the question or missed the instructions and scored very few marks. Many candidates chose to measure the volume of gas evolved and connect this to the mass change. While not wrong in itself those that chose this route often ignored the water evolved and the calculation became impossible. A significant number thought that they were dealing with all three reactions and were matching three samples to the three equations. Some also assumed it was possible to recognise Na_2CO_3 , Na_2O , and NaOH by looking at them and thus know which molecular mass to use in the calculation. A common error was to suggest that accuracy could be improved by repeating the experiment. This will only improve reliability.

Hints for Revision

- Make sure you use technical language correctly for example if then you mean solution then say solution.
- Make sure you understand the reason behind set procedures used in volumetric analysis.
- When drawing structures for organic compounds make sure you use all the information given and check that the compound you have drawn has the same molecular formula as that asked.
- Take care when you draw OH groups to bond the C to the O and not to the H. Do not use pencil on scripts that are to be marked on-line, the scanner may not always be able to read your answer.
- When you carry out a calculation of a reacting ratio the answer will generally be a simple whole number. If it is not go back and check you have not made a slip on the way through the calculation.
- In plans time taken to think the answer through can save time in the long run. Marks are for clarity not quantity.
- In enthalpy calculations before writing the final answer revisit the data and then write the appropriate sign.

Unit 6244/01

General

This paper seemed to be accessible to the full range of candidates. There was no evidence of any time pressure, with the vast majority of candidates attempting every question. The paper contained some relatively straightforward questions, along with a number of more challenging ones. Some excellent scripts were seen by the team of examiners. Answers to calculation questions, in particular, were often laid out clearly and logically. Many candidates, however, still do not consider carefully the number of significant figures to which it is appropriate to quote their answer. Unfortunately, however, a significant number of candidates had problems in expressing themselves in clear, unambiguous English and, in longer answers, there was a tendency to repeat and/or contradict earlier statements.

Question 1

In (a)(i), many candidates could define the term **acid**, but the definition of the term **weak** proved more problematic. The Quality of Written Communication affected many answers, with imprecise use of chemical terminology prevalent here on many occasions. In (b), many candidates gave the state symbol of sodium carbonate as a solid in their equation. This occurred despite being told in the question that aqueous solutions of methanoic acid and sodium carbonate had been reacted together.

The new format provided for candidates to answer (c)(i) proved to be highly successful with candidates and examiners alike and many correct responses were seen. In (c)(ii), the denominator occasionally included an extraneous $[H_2O]$. Examiners saw many very good answers to (c)(ii) and (iii). In (c)(iii), the pH was often calculated correctly, except where candidates omitted to take the square root in order to calculate the value of $[H^+]$ from their expression containing $[H^+]^2 = \sqrt{1.6 \times 10^{-6}}$ or where candidates incorrectly rounded the answer to 2.39. In (d)(i), a large number of candidates derived or recalled a correct expression for the pH of the buffer solution. The concentrations of the acid and salt in the buffer mixture, however, were often not calculated correctly. This was for a variety of reasons, such as not appreciating that the initial concentrations of methanoic acid and sodium methanoate would be halved on mixing equal volumes. In (d)(ii), a significant number of candidates simply gave a correct definition of the term **buffer solution**, but did not go on to explain the effect of adding hydrogen ions and of adding hydroxide ions in small quantities to such a solution. A surprising number of candidates showed the dissociation of the sodium salt as a reversible process in their equation having stated elsewhere that it dissociated completely. In many cases where two correct equations had been given, the fact that the concentrations of the acid $[HCOOH]$ and sodium methanoate $[HCOONa]$ were large, in comparison with those of the added hydrogen and hydroxide ions, was often overlooked.

Question 2

Examiners saw many excellent answers to the calculation in (a). However, a significant number of candidates were unable to deduce the molar amounts of each substance present at equilibrium in (a)(i). Many answers suggested that the total number of moles of each component present at equilibrium had to equal the total number of moles present initially. Consequential marking for (a)(ii), (iii) and (iv) allowed the remaining available marks to be awarded in such cases. However, in (a)(iv), the units were not always correctly stated. Dimensions such as $\text{mol}^{-1} \text{dm}^3$, appropriate to K_c calculations, were used instead of atm. In (b)(ii), it was rare to see both marks awarded as very few candidates firstly invoked the change in the value of K_p in order to **then** explain the shift in the position of equilibrium. There were many excellent answers to the short-answer questions in (c) and (d).

Question 3

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), structural formulae were written despite the requirement in the question to show all the covalent bonds. In (b), the structure of the 2,4-DNP derivative proved difficult for many candidates to recall. Frequently the carbon and nitrogen atoms were drawn with an incorrect number of bonds connected to them. The iodoform reaction was known by many in (c)(i), as was the reduction of a ketone to a secondary alcohol in (c)(ii). Many candidates simply gave the general answer “secondary alcohol” instead of identifying the alcohol specifically as butan-2-ol. In (d)(i), the fact that the isomers were non-superimposable mirror images was omitted in favour of stating either that an asymmetric carbon centre was present or that the central carbon atom in the molecule was connected to four different atoms or groups. In (d)(ii), a significant number of candidates was under the impression that the **molecules** themselves rotated when plane polarised light was passed through the solution. Verbs such as ‘bend’, ‘deflect’, ‘reflect’ and ‘refract’ were used instead of **rotate**. Some idea, stated or implied, that the isomers

rotated the plane of polarisation in opposite directions was required.

In (c), many were unable to draw the formulae of the two isomers of the unknown substance, Compound **C**. Candidates did not always appreciate that there was evidence to identify Compound **C** as containing the $-\text{CH}_2\text{OH}$ group (from the third bullet point of the question).

Question 4

In (a)(i), candidates found writing the equation which represented the enthalpy of atomisation of bromine quite challenging. Common errors that were seen included showing bromine as a gaseous element in its standard state or starting with one mole of the element to form two moles of gaseous atoms. In (a)(ii), the term lattice energy was often defined correctly, although a significant number of candidates suggested that the process was endothermic by stating that it was “the energy required....” Some excellent answers to the calculation in (b)(i) were seen, whereas others showed a lack of thorough knowledge of the Born-Haber cycle. The requirement to double the enthalpy of atomisation of chlorine was frequently overlooked and many did not realise that the cycle given on the question paper showed twice the first electron affinity of chlorine. Following on from this, a significant number of candidates were unable to construct an appropriate expression to calculate the first electron affinity. For example, negative signs appeared in the final answer, or the final answer was divided by two, when this did not follow on logically from the original working. Pleasingly, it was very rare to see no attempt made to answer this part of the question. In (b)(ii), many candidates realised that magnesium chloride had covalent character, but some thought that the anion polarised the cation rather than the other way round. 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. In (c), most candidates knew that the size of the metal cation would affect the lattice energy, but they did not acknowledge that the charge on the Group 2 metal ion remained the same. Many candidates omitted to mention that the diminishing lattice energy arose as a

result of weaker forces of attraction between the positive and negative ions in the lattice. A substantial number referred to charge density, but if this term is used it should always be followed by an explanation.

Question 5

Part (a) provided a good start to the question for many candidates as they were able to recall the formulae of the chlorides correctly. The equation in (b)(i) proved somewhat more problematic than expected for a sizeable number of A2 candidates. Sodium hydroxide and hydrochloric acid were frequently given as the products obtained when sodium chloride was added to water. Candidates who realised that sodium chloride dissolved in water, rather than reacted, found it difficult to represent the process in the form of an equation. In (b)(ii), many did not link the **type** of bonding in the chlorides to the **behaviour** with water. For (c), full marks could not be obtained for answers which focused solely on steric hindrance. Those who used the more productive explanation of dative bonding via the lone pair of electrons of the oxygen atom in water towards the 3d orbitals of the central silicon atom in SiCl_4 were often penalised for loose terminology. For example, statements such as “silicon tetrachloride has 3d orbitals” were frequently seen by the examiners. In (d)(i), the balanced equation was often completed correctly. In (d)(ii), the increasing stability of the +2 oxidation state down Group 4 was known, but no mark was awarded unless a comparison was made with the +4 oxidation state.

Question 6

The short answer questions in part (a) were often answered well. However, the use of a mineral acid in order to hydrolyse a nitrile was not always known in (iii). In (a)(iv), the formula of the substituted amide was correctly given but the formation of hydrogen chloride as a co-product was then overlooked. In (b), those who had learnt the reactions of Grignard reagents were handsomely rewarded, but many candidates who knew the identity of the products then did not display all bonds when drawing the structural formulae.

Hints for revision

- 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 of gases.
- Learn your definitions thoroughly, such as enthalpy of atomisation.
- Practise writing equations which help you to explain how a buffer solution works.
- Read the question carefully.

Unit 6245/01

Introduction

This paper tested the full range of knowledge and skills required by the specification. Some candidates performed outstandingly well. The paper contained some straightforward questions together with some that tested candidate's ability to explain clearly a point of chemical theory. Some candidates had difficulty expressing themselves and in some places produced statements that addressed issues that had been asked on previous papers but not on this one.

Question 1

Most candidates scored well in (a) (i) showing understanding of the concept of order. Loss of this mark was generally down to failure to include reference to the rate equation or the concentration. Part (a)(ii) was well done by most candidates with many scoring three marks. However, some candidates lost a mark because they did not make it clear which mixtures were being compared or, more often, that the concentration of one of the reactants was being held constant while the other was changed. There are many ways data of this type can be used to generate the rate equation and all received the appropriate marks. Some candidates chose a mathematical route to produce the correct orders but it was not always clear where the numbers came from and the layout was often confused. There has been a major improvement in candidates' ability to deal with units and all but the weakest candidates got the correct value for k in (a) (iii). There were three possible answers in (a) (iv) and all were seen in equal proportions. Confusion between rate constant and rate was seen in many cases.

The general standard of drawing of the Maxwell-Boltzmann distribution curves in (b) was poor. Examiners are not looking for perfect drawings but they must not look like a Gaussian distribution. The major error was generally to draw the downward curve in such a way that it became asymptotic to the axis well above the x – axis. Most candidates could correctly annotate the curve to show typical activation energies for an uncatalysed reaction and a catalysed reaction. The only common errors were to reverse the line or to put the activation energies so close to the peak of the curve that the reaction would probably have been explosive. Many candidates chose to shade in and label the areas under the curve after the activation energy. This was not required by the question and may have led to some confusion about what was being asked in (b) (iii). Many candidates did not understand what was expected of them in part (b) (iii). They explained the effect of temperature change on rate by reference to the areas under the curve and others talked about graphs moving to the right rather than the curve. A significant minority of candidates suggested that the total area under the graph increased. There was considerable evidence of chemical knowledge in the answers to (b) (iv) which unfortunately did not answer the question asked. Candidates were asked to suggest a process that used a transition **metal** as a catalyst and this does not include the Contact Process (V_2O_5). Examiners were expecting to see the name of the compound not just the title of the process. Most chose ammonia. The mark for the explanation of why the elements and their compounds can act as catalysts was scored by most candidates by reference to variable oxidation states but only the very best candidates realised the importance of available d - orbitals in bonding to reactants. Part (b) (v) proved a challenge to many candidates who simply discussed the effect of the catalyst on the rate rather than the rate constant.

Question 2

Many candidates described the standard hydrogen electrode rather than the chlorine half-cell asked or gave generalised conditions without specific mention of Cl_2 gas or chloride ions. The equation in (b) (i) presented few problems to most candidates though reversed reactions or reactions with Cu^+ on both sides were seen as well as reactions with electrons remaining on one side. The ideas of feasibility of a reaction were generally well understood and most candidates calculated the value required even when their equations were incorrect. Some candidates continue to argue that the $E_{\text{cell}}^{\ominus}$ must be greater than +0.4V for a feasible reaction. The majority of candidates clearly understand the ideas associated with disproportionation and scored both marks. General definitions of disproportionation and those that did not make clear the actual oxidation number changes involved struggled to score.

Very few errors were seen on the electron configuration of Cu^+ . Statements of the type of reaction occurring between hydrated copper (II) ions and ammonia were generally correct but the colour of the complex was often stated as blue. This did not score as the solution was already blue. The examiners saw many concise, well explained reasons for the colour of complex ions in solution. However, some candidates still referred to splitting of the d – orbital rather than d – orbitals, imply that the ligand causes the promotion rather than absorbed energy from light, and more suggestions than usual that the colour is due to an emission spectra. There was some confusion in part (d) (iii) among candidates who argued that because the d – subshell was full no splitting could occur or that Cu^+ is not a transition metal so is not coloured. The best answers concentrated on the full subshell and the impossibility of d – d transitions.

Most candidates scored the mark for the shape and many the full three marks. The main errors were incorrect statements concerning the bond angles (90/120/107 were given) or failure to identify the repulsion forces as those between **bonding** pairs of electrons.

Question 3

The reason for the single peak in the benzene n.m.r. spectra was poorly understood. Many answers raised issues that did not relate to n.m.r. at all such as the delocalization of electrons or its ability to undergo substitution.

Most candidates scored very well on (b) (i) and (ii) and many on the mechanism. Candidates showed how the electrophile was generated and their use of curly arrows to show electron movement was precise. Areas where detail could be improved include curly arrows from the delocalised electron circle going to the wrong carbon in the CH_3CO^+ or the oxygen, careless drawing of the intermediate with the electrons delocalised over very few carbon atoms and the final step showing the curly arrow starting from the H not the bond.

Many combinations of the reagents for cyanide addition to the carbonyl group were allowed and most candidates scored marks here and in part c (ii). Unlike the mechanism in part (b) this was very poorly done and answers showed very little understanding of what was happening in the reaction. Many errors started from a failure to identify the nucleophile and began with the self-ionization of the carbonyl group or attack by HCN or uncharged CN. Some of those who correctly reached the intermediate then missed the final mark by showing a curly arrow **from** the H^+ .

The isomers in (d) (i) were generally well drawn and made the three dimensional shapes clear. In (d) (ii) many candidates had a clear understanding of why the mixture would not rotate the plane of plane polarised light but suggested the reason was due to a planar carbocation intermediate. Unfortunately for those candidates, this was the answer to a question on a previous paper not the answer to the question asked on this one which concerned attack on both sides of a planar **initial** compound. This common incorrect answer suggests that candidates are making assumptions

about questions set on the basis of what has been asked before rather than on what is actually on the paper. Some candidates only tried to explain the lack of rotation and did not mention the mechanism at all.

Part (e) proved quite discriminating with candidates referring to peaks due to phenylethanone or ketones not referring to peaks or absorptions at all.

Question 4

Apart from (a) in which almost all candidates scored both marks this was for most the poorest answered question on the paper. Very few could draw a boiling temperature-composition curve which showed a reasonably correct shape without a maximum or minimum, correctly labelled axes, and tie lines that started from a sensible point and were joined together. Some explanations communicated clear chemical knowledge but many were a jumble of ideas that often suggested that the lower boiling temperature component boiled off first and left the other behind. In some answers poor communication skills made it seem that during the fractional distillation the mixture was heated, produced a vapour richer in the more volatile component which was collected and then heated to produce a new mixture and so on until a pure liquid was produced. Some candidates chose to use the space to draw a diagram of the apparatus.

Most candidates scored two or three marks for the halide test but did not describe it in such a way that it would work for an halogenoalkane. Many did not hydrolyse the liquids with sodium hydroxide, omitted the need for heat or did not fully neutralise the excess alkali (very common).

Part (d) proved difficult for many candidates who failed to communicate their understanding of the problem and its solution. Most suggested that the use of mass spectrometry would be the better option because the hydrogen structure of the two compounds would produce similar n.m.r spectra but could not clearly explain what would be seen in the mass spectrum. Vague references to mass rather than m/e values or the presence of Cl^+ or Br^+ ions were common.

Question 5

Section (a) generated many excellent answers with clear reasoning shown. Most candidates got the two mole calculations correct but some then reversed the ratio. Candidates should beware of rounding up or down answers too early in a calculation because as in this case it can give a wrong ratio such as 1:4 which then leads to difficulties. A sizeable minority of candidates derived the equation first and then proved that the results were consistent with it (OK) but several then used the equation to derive the moles of Br^- and the ratio 1:5 (not OK).

In questions of the type asked in (b) candidates should remember that they are taking a chemistry paper and that the answers should generally involve chemistry not vague ecological statements. Thus this was a specific question concerning the use of poly(ethene) to store acidified potassium manganate(VII) solutions and the answer must make reference to the chemical properties of both. In (ii) it was necessary to make reference to the problem caused in landfill sites not just that it is biodegradable.

Hints for revision

- Read the question carefully and make sure you understand what you are being asked to do. It may look like last year's question but it will not require the identical answer.
- Read what you have written to make sure you have not left out a vital point and that you have communicated your ideas clearly.
- Do not confuse *rate* and *rate constant*.
- Practise drawing standard sketch graphs such as the Maxwell-Boltzmann distribution and boiling point composition curves.
- Learn common explanations such as colour in transition metal ions and fractional distillation.
- Practise writing out common mechanisms particularly nucleophilic addition to carbonyl compounds.
- Make sure that your answers concentrate on real chemistry not vague references to it.

Unit 6246/01A

General

The Practical Paper at A2 has evolved into a well established style, with an emphasis on qualitative analysis. Inorganic and organic compounds are used as unknowns in these exercises. For the quantitative input a redox titration was included, with a structured calculation. A plan based on thermochemistry completed the suite of questions. Centre supervisors are reminded of the need to submit a report in order that candidates' accuracy may be assessed. Without this it is impossible to judge how candidates have fared and high or low titres may be considered beyond the acceptable range when in fact they were perfectly in accord with solutions prepared locally. It is often helpful to have a report on the qualitative exercises, although this is very seldom seen.

Question 1

The inorganic unknown here was ammonium iron(III) sulphate, which presents as pale violet crystals. However, given the wide range of purity of samples available at overseas centres, a range of colours was accepted and some consequential marking allowed with the inferences. Examiners were surprised to see how many candidates lost marks in this question through not giving the identity of precipitates, especially given the fact that this was asked for explicitly in the question. The tests all worked well. The colour change with thiocyanate ion was universally seen, but the reaction (ligand exchange) eluded many. The test for sulphate gave all two marks.

Question 2

The unknown here was a mixture of propanone and ethanoic acid, taken to emulate oxopropanoic acid. This it fulfilled perfectly, as evidenced by the fact that all of the tests gave the expected outcomes. The stress placed on several words in the instructions failed to alert many candidates, who lost marks through poor reporting. Candidates are advised to carefully read the questions, as each year will contain some slight variation on a theme. The 2,4-dinitrophenylhydrazone precipitate indicates aldehyde and/or ketone, yet candidates saw the oxidation test as a means of identifying a tertiary alcohol. Every year, despite comments and recommendations made in this report, candidates lose marks through unthinking copying from their analysis schemes. Surprisingly few candidates marked M^+ as requested, yet virtually all recognised that this was 88. It was pleasing to see many clear molecular structures drawn.

Question 3

Redox chemistry is covered in the A2 content so it is an appropriate subject for a practical question. In this particular paper the titration was iron (II) against manganate(VII). It would seem that the majority of candidates could still employ the practical skills learned for AS. Very few problems were encountered with the data table, but still a few candidates read burette scales inappropriately. The calculation was accessible to most, presumably helped by the structure that was provided.

Question 4

As always it is the plan that candidates find the most difficult, this is presumably because there is no familiar structure to this as there is to the qualitative tests. That said it was pleasing to see that some candidates wrote a very precise and succinct account. Candidates are reminded that their accounts should be written as if for another member of their group. Knowledge of basic practical procedures can be assumed, but manipulations specific to the procure should be stated clearly. Some intricate suggestions as to how to process the data revealed an unsafe understanding of what exactly was occurring.

Hints for Revision

- Be sure to give the inferences required by reading carefully the demands of the question
- Remember that the qualitative exercises are designed to establish the identity of an unknown, and that therefore the test results and inferences should narrow down the possible ions or functional groups.
- Although this is an open book examination beware of plans from previous papers that look similar to that in the present paper. Adapting these requires skill.
- Signs of charges on ions should be clearly shown, and remember that instructions to mark M^+ on a mass spectrum should be heeded.

Unit 6246/02

Introduction

Many of the items in this paper generated some excellent answers, and there was clearly a good number of candidates who could express their ideas clearly and show steps in calculations accurately. However it was also true that many did not read the questions properly, and answered some other question that they had seen in a previous paper. In particular, the answers on the equilibrium reaction for the oxidation of ammonia did not contain the required explanations, looking more like a general answer to a different question on industrial equilibria. Despite being emboldened in the questions, **all** (2(f)), **explain** (3(a)(ii)), and **change** (4(c)(ii)) were ignored by many. Calculations were generally set out well and were easy to follow, though of course a minority of offerings was highly opaque. Some candidates seem to launch into their calculations without having much idea of where their equations are going to take them. Others in wordy answers have a tendency to repeat the question in the answer space and then stop when they have filled all the lines irrespective of whether the necessary points have been given.

Question 1

The dichromate/chromium(III) half-reaction expected in (a)(i) proved to be a problem for numerous candidates, who could not get the number of electrons correct, although oxidation of Cu to Cu²⁺ was known by virtually all. The calculation in (ii) could score consequentially from the stoichiometry derived in part (i); many candidates picked up credit in consequence. If candidates got part (i) right they usually succeeded with the calculation also. Some ignored the instruction on significant figures. Surprisingly few could say what the two coloured precipitates were in (iii), and even fewer knew of the existence and colour of Cr(OH)₆³⁻. Mostly the solution was thought to be blue.

Many candidates gave a good account of recrystallisation; the commonest omission was to fail to mention that the *minimum* amount of hot solvent is required.

Question 2

This proved to be the least popular question; however many of the candidates who did attempt it gave a good account of themselves.

The isomer required in (a) was often correct, only a very few candidates gave a structure that was an isomer which could not have been obtained in the reaction. A few gave the same structure as **B**, but simply rotated 60°. Understanding of the NMR spectrum was very weak, even amongst the better answers. Very few knew that there would be four peaks; some thought three, and could score one mark, but many candidates had no idea and guessed. In contrast a large number knew the structure of the ion in the mass spectrum and gave it with the correct charge.

Both of parts (c) and (d) were answered well on the whole, so candidates who knew their organic reactions thoroughly found this a straightforward test. Many of the mechanisms in (e) were competently drawn, though there was a minority that regarded the curly arrows as more of a decorative device rather than a representation of what the electron pairs do during the reaction. Virtually all knew Markovnikov's rule and showed the positive charge on the correct carbon atom in the carbocation. It is a good idea for candidates to separate out the several steps, so in this case to write the intermediate carbocation twice, rather than cascading the whole process. This is true for all multi-step mechanisms.

The answers on intermolecular forces in (f) were by far the weakest offered in this question. Candidates seemed not to realise that **all** intermolecular forces (emboldened in the question) required them to consider permanent dipole-dipole and van der Waals' forces in both **A** and **C** in addition to the hydrogen bonding in **C** alone. Most answers considered only van der Waals' and hydrogen bonds.

Question 3

The calculation of ΔH for the oxidation of ammonia was competently performed by a majority of candidates, very few thinking that the reaction is endothermic. In (a)(ii) candidates were required to **explain** the effects of temperature and the use of catalysts on rate and yield. Very few scored full marks here. This was partly the result of answers being given to other questions that had been answered before, and partly a failure to understand what an explanation really is. Thus the increase of rate with increasing temperature (candidates should be discouraged from using the term 'with temperature' to imply an increase) was universally known, but was not then explained in terms of a greater proportion of the collisions having an energy greater than the activation energy. The question of the yield related to temperature was handled rather better, though some still believe that the change in equilibrium composition changes the externally-imposed temperature. Most knew that the catalyst did not affect the yield, but then did not explain this by mentioning the effect on the rate of the forward and the back reaction, or by the lack of any effect on the equilibrium constant.

The calculation in (b) on enthalpy of neutralisation was often correctly performed.

The test for ammonium ions and for nitrate ions in (c)(i) showed a good understanding on the part of many. Some used NaOH to show absence of ammonium ions, and then used a brown ring test for nitrate; this is a perfectly good answer. Others used aluminium in alkali for nitrate; however for weaker candidates this part proved too difficult, and either fictional tests were offered or candidates suggested that brown fumes would be obtained on heating the solution.

The thermal stability of nitrates of Group 1 in (c)(ii) was sometimes answered well, but a surprising number of responses omitted to mention that the charge on all the Group 1 ions is the same. Weaker answers meandered through ideas of shielding or ionisation energy but were unable to make any progress.

Question 4

Virtually all candidates could write the dot-and-cross diagram for HF in (a)(i); surprisingly few scored well in (ii), mentioning little beyond the electronegativity difference between H and F. Most underestimate the importance of the small size of the fluorine atom in producing strong hydrogen bonds.

In (b)(i) the question explicitly stated that the dissociation of HF in water should be shown in the equation, but perhaps half of the candidates omitted the water. Such answers could score consequentially for K_a , but too many lost a mark for failing to read the question accurately.

Clear, careful answers to the problem of calculating the pH of the HF/NaF buffer were rare. A significant number of candidates failed to recognise that a reaction had occurred when the solutions are mixed at the start, and were unable to calculate the necessary concentrations correctly. Some consequential credit was available, but even this could not save those who used inappropriate equations to begin with because they had not realised that the mixture is a buffer. Candidates who choose to use the Henderson equation are less likely to get the correct answer owing to mathematical errors. Very few were clear in part (iii) that a large reservoir of both HF and F^- ions is needed to make a buffer; some scored one mark for one of these, but the weakest simply defined what a buffer is. The shape of BF_3 was almost universally known. However, candidates again answered some other question to that set and did not address the *change* in bond angle around the boron atom and relate it to the number of electron pairs around the boron atom in the adduct. A number of answers gave general principles of VSEPR but did not directly relate these to the substances in the question.

Hints for revision

- Make sure that you read the entire question in any examination, and see exactly what it is asking. It will not be the same question that you have seen in similar papers previously.
- Do not repeat the question in the answer space; make sure you know how your answer will end before you begin to write.
- Read through the whole paper before you begin to write anything.
- In mechanisms with several steps, write each step as a separate equation.
- Understand clearly what is meant by **explain**; some underlying theory will always be needed.
- Practise thinking of extended answers as a list of points which you then join up into connected prose.
- Always put the sign in for enthalpy changes, whether positive or negative – do not leave a positive sign to be assumed.
- Learn practical techniques and tests thoroughly – they do not only appear in practical examinations.

Appendix A Statistics

6241/01

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

6242/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	46	41	36	32	28
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	73	66	59	53	47
Uniform boundary mark	120	96	84	72	60	48

6243/01A + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	73	66	59	53	47
Uniform boundary mark	120	96	84	72	60	48

6243/01T tcwk+ 3B

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

6244/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	58	52	46	40	34
Uniform boundary mark	90	72	63	54	45	36

6245/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	56	50	44	39	34
Uniform boundary mark	90	72	63	54	45	36

6246/01A + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	77	70	64	58	52
Uniform boundary mark	120	96	84	72	60	48

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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