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Unit 6241/01

General

This paper proved to be accessible to a wide range of candidates giving opportunities to show an understanding of basic work. It also had more demanding questions requiring both 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. While there was an overall improvement in the use of technical vocabulary there remain candidates who do not appreciate the necessity for accuracy in their choice of words or the need to apply ideas in answering specific questions rather than just repeating standard definitions.

Question 1

Only the best candidates gained full marks for Q1 (a); many did not know the formula for calcium hydroxide although candidates who knew the formula were usually able to balance the equation. There were frequent descriptions of the reaction of an alkali metal with water and confusion between the requirements of observations and inferences. Most candidates were familiar with the trend in the solubility of the group two hydroxides.

The calculation in (c)(i) was completed successfully by the majority of candidates although some used atomic number rather than relative atomic mass. Part (c)(ii) is a standard question on this paper but it requires the application of some key concepts. There were some very clear and correct answers to (c)(ii) but even good candidates omitted to record that the charge on the cation remains constant and there was frequent confusion between atoms and cations and between polarising power and polarisability. Some candidates referred to the nitrate as a molecule and others attempted to answer in terms of the bonding between the cation and the nitrate.

Question 2

While there were many accurate diagrams of ammonia in Q2 (a), a significant number of candidates seemed unaware of the conventions used by chemists to represent three-dimensional molecular shapes. Most candidates knew the bond angle although it was quite common to see this given as between an N–H bond and the lone pair. Explanations of the shape frequently referred to repulsion between the N–H bonds or the hydrogen atoms rather than to the electron pairs, and the number of electron pairs was often omitted.

In (b) most candidates were familiar with the electronegativity difference between nitrogen and hydrogen but the asymmetry of the ammonia molecule and the resulting net dipole were not well understood. Candidates often concluded that ammonia was symmetrical and therefore non-polar or that the polarity was due directly to the presence of the lone pair. The absence of molecular polarity was also ascribed to the charges cancelling.

Part (c) produced some excellent answers with the best candidates showing a detailed awareness of the range of intermolecular forces operating with these molecules. Marks were lost when candidates failed to compare the strengths of the intermolecular forces involved and hence the different energies required to break them. Despite the guidance given in the question some candidates still implied or

stated that either covalent bonds were being broken, or that the bonding within the molecules was hydrogen bonding or van der Waals' forces. The common errors in (d)(i) were failure to specify that the lone pair was located on the nitrogen atom and that the resulting dative covalent bond was with the hydrogen ion.

Question 3

The concepts tested in (a) were well understood by most candidates and those who endeavoured to explain the steps of their calculations clearly were most likely to score full marks. Part (a)(ii) was the most likely to cause difficulties: candidates often divided their answer to (a)(i) by a thousand and multiplied by ten or used incorrect units, mol/dm^{-3} , being common. Answers to (b) frequently omitted to specify that the metal was a lattice or ordered array and that the particles involved were positive ions and, while the great majority of candidates were aware of the metal's delocalised electrons, explanations of metallic conductivity often relied on statements such as the electrons were 'charge carriers'. A minority of candidates believed that the ions were flowing under the influence of the potential difference.

The responses to (c) were generally better than those to the similar question in June 2005 but many candidates were unable to identify the forces broken when chlorine melts and, while sodium chloride was usually identified as ionic, candidates often went on to refer to it as molecular or macromolecular and as having covalent bonding or van der Waals' forces. The definition of first ionisation energy (d)(ii) was well known but the candidates often compared the ionisation energies of sodium and chlorine in terms of sodium 'wanting' an inert gas electronic configuration.

Question 4

The answers to (a), (b), (c) and (d) were generally well known: a minority of candidates defined oxidation rather than oxidising agent and some suggested halogens other than fluorine as the most powerful oxidant. Few candidates gained full marks for (e). Balanced ionic equations were rare, sodium compounds were common and a number of candidates placed acids on the right-hand side of the equation, despite the presence of sodium hydroxide. Marks were awarded only for explaining the process in terms of the redox processes occurring in the specified reaction but many candidates simply gave a definition of disproportionation or stated the changes in oxidation numbers occurring. A small number of candidates believed sodium hydroxide to be involved in the redox processes.

In (f)(i) while some candidates gave accurate equations showing electron affinity, many showed the chlorine molecule gaining an electron. In answering (ii) most candidates appreciated that repulsion would result in an endothermic second electron affinity but a significant number referred to the repulsion between electrons rather than ion and electron. Some candidates sought to explain the thermicity in terms of the chloride ion already having a stable electronic structure.

Question 5

For (a)(i) most candidates were able to write the electronic structure of aluminium although a small number attempted to use the mass number rather than the atomic number. While there were many correct responses to (a)(ii) some candidates overestimated the difference between the second and third ionisation energies while underestimating the difference between the third and fourth. A substantial minority of candidates placed the third ionisation energy below that of the second. Most candidates were able to give the correct equation in (b)(i) but in (ii) the equation was often unbalanced (candidates giving 2 electrons rather than 4) or expressed in terms of oxygen atoms rather than molecules. Even when the half ionic equations were correct the final equation was often unbalanced or gave the product as ions rather than aluminium oxide.

Hints for Revision

- Have a clear understanding of the different types of particles involved in chemical systems (atoms, ions and molecules) and their distinctive characteristics.
- Be able to draw the common molecular shapes with clear three-dimensional representation and keeping to the usual conventions of these diagrams.
- In answering questions about bonding and intermolecular forces remember the need to specify clearly the particles involved.
- Show working in calculations.
- Practise writing ionic equations.

Unit 6242/01

Candidates found most of this paper straightforward. The distinction between the weaker and the stronger candidates became evident wherever there was a need for more extended writing, namely in thermodynamic versus kinetic stability, the relative reactivity of ethane and ethene towards bromine, and to a lesser extent in the justification for the choice of temperature used in the Contact Process.

Although candidates have been improving for some years now in the quality of the layout of their calculations, this feature was sadly absent from some of their work this time. Examiners also had the feeling that too many candidates were wholly unconcerned with presentation of diagrams.

Some candidates appear to have no idea how their answer will end when they begin to write it - this is particularly true of questions requiring more extended writing. Thinking of the answer as a list of points would help. All candidates would benefit from taking a few minutes at the beginning to read the entire question paper rather than starting to write immediately.

Question 1

Most candidates understood that in a dynamic equilibrium the rate of the forward and back reactions is the same; some were let down by poor expression and said that 'the forward reaction is the same as the back reaction'. Fewer made reference to constant concentrations at equilibrium; of those that did, some said the 'amounts' were the same or that the concentrations were 'all the same'.

The conditions of temperature and pressure required for the Contact Process were widely known, and many could explain the temperature used in terms of the conflicting requirements of yield and rate. Not all achieved the third mark by explaining that the temperature used is necessarily a compromise.

Numerous candidates simply regarded the use of higher pressures as 'too expensive'; this is not enough, and for credit requires some reason for the cost, for example that the extra yield obtained does not justify it. Too many candidates have an apocalyptic view of industrial chemistry, believing that high pressures are 'too dangerous', having failed to notice that industrial high-pressure processes are routine.

The enthalpy change for the forward reaction was calculated correctly by the majority. The usual mistakes appeared, principally candidates failing to use the correct multiplying factors. A minority quoted a positive value for the answer, failing to link it with the information given in the question stem that the reaction is exothermic.

Very few candidates knew that the enthalpy of formation of an element is *defined* as being zero. Other forms of words could score, but generally this was a poorly answered question.

The vast majority knew the formula for the catalyst used in the Contact Process.

The enthalpy level diagrams usually contained the correct information, though too many were carelessly drawn and looked like rough notes. The profile for heterogeneous catalysis should properly have an intermediate stage where the

reactant is combined with the catalyst; this was not insisted upon, though was shown on many occasions. There was a sizeable minority that offered a Maxwell-Boltzmann distribution - perhaps a reflex reaction to the use of 'catalyst'. Candidates should be aware that in diagrams the use of colour does not generally enable an easy distinction between different lines; on-screen marking is entirely monochrome. Pencil and ink cannot readily be distinguished. In most cases there was enough information in other ways to enable the script to be marked; a few, however, had to be marked conventionally because of the use of red or green ink.

Many candidates understood that a catalyst provides an alternative reaction pathway of lower activation energy. However, fewer stated clearly that the *proportion* of successful collisions is increased as a result. One or two demonstrated a good understanding of what happens on the surface of a heterogeneous catalyst.

The reason for using concentrated sulphuric acid as the absorbent for sulphur trioxide was poorly understood by a surprisingly large number. The knowledge of the production of an acid mist was remarkably rare.

Question 2

Hess's Law was on the whole well understood; a small minority failed to mention enthalpy change at all.

Most candidates calculated the enthalpy change for the combustion of methane correctly. A minority failed to subtract the quantities the correct way round, and obtained an endothermic value for a combustion reaction. Mostly the calculations were set out reasonably well, though some candidates resolutely resist using words to enable their calculation to be read more easily.

Many identified the enthalpy of combustion correctly; the common errors were 'exothermic' and 'formation'.

Most candidates knew what standard conditions are.

The reason for the calculated enthalpy change being different from the standard value was generally attributed to the use of mean bond enthalpies. Many fewer noticed that the water produced in the equation was in the gaseous phase and that therefore this would have to be taken into account somehow since, under the commonly quoted conditions for the standard state, water is a liquid.

The difference between thermodynamic and kinetic stability was rarely well-explained. Many candidates showed a combination of confused chemical knowledge and poor expression. Thus 'the reaction' was said to be thermodynamically unstable rather than 'the reactants', or exothermicity was mentioned without any reference to the relative energy levels of the reactants and products. Discussion of kinetic stability sometimes omitted any reference to the activation energy. Yet others confused the two ideas. The weakest candidates seemed to have no idea of what they were going to write before they began, so produced rambling and incoherent responses.

Question 3

Most candidates knew that photobromination of ethane is a radical process, and could write the overall equation for the reaction. A small number thought that dibromoethane and hydrogen are produced.

Most candidates also knew the equation for the reaction of ethene and bromine; those who did not score failed to use structural formulae as directed. Most also knew the name of the product from the reaction.

An understanding of the relationship between the bonding and reactivity in ethane and ethene was seldom fully demonstrated. Virtually all referred to the π - and σ -bonding in ethene; fewer to the presence of σ - bonds *alone* in ethane; and even fewer to the need to break a C-H bond if ethane is to react. The majority focused their attention on the C-C and the C=C bond in the two compounds, and so missed the essential points regarding ethane.

Question 4

Most candidates could draw the two isomers of but-2-ene, though a minority failed to show the hydrogen atoms. This must be done - a stick representing the bond is not enough.

Geometric isomerism in but-2-ene, and its absence in but-1-ene, was seldom clearly explained. Most candidates knew of restricted rotation about the C=C bond, but then became bogged down in trying to explain the difference between the two compounds in terms of their substituent groups. A general diagram showing which groups can be the same and which must be different would have saved the day for many.

Virtually all gave another acceptable isomer of C_4H_8 ; a significant number of these were *cyclobutane*.

Most candidates gave the correct structure of the polymer chain of poly(propene); those who did not predictably showed all three carbon atoms in the chain.

Too many answers showed a reflex response to the problem of disposal of poly(propene) in a landfill site. Essentially the polymer does not biodegrade and fills up the site, but candidates had other ideas. These included production of toxic gases from a substance they had already said did not decompose; production of toxic gases on burning, which was not asked; and all sorts of vague (and fictional) environmental 'problems' including entry into the food chain.

Question 5

Many candidates found this question straightforward. The errors were on the whole predictable. Butan-2-ol in the first part was sometimes given as butan-1-ol, and the oxidising reaction sometimes omitted the use of sulphuric acid. For the conversion of a halogenoalkane to an alcohol the use of *aqueous* sodium hydroxide was sometimes omitted. Many candidates knew that but-2-ene gives only one product with hydrogen bromide.

The tertiary alcohol expected as the non-oxidisable isomer was sometimes given as a secondary or primary alcohol.

The elimination reaction giving but-1-ene was understood by many and the conditions required were known.

Hints for Revision

- Definitions are often worded very precisely; learn definitions carefully.
- Lay calculations out with some words to explain what you are doing; calculations that are easy to read are easy to mark, and show understanding.
- Draw diagrams carefully and label them unambiguously. Do not use colour.
- Rehearse more complex ideas by putting them into list form; it makes them easier to remember and understand.
- Look very carefully at organic structures; lay them out in a variety of ways so you can spot structures that are in reality the same but written in different ways.

Unit 6243/01 (Coursework)

General

A number of previous Examiners' Reports have explained in some detail the ways in which some centres have failed to operate and administer the assessment scheme correctly. Most of the criticisms levelled at centres would not have been necessary if assessors had read, noted and implemented the instructions and advice in the introduction to 8080 Internal Assessment of Practical Coursework guide (Issue 2 January 2003), pages 1 to 4. The moderators strongly suspect that some centre assessors have not read these pages or have done so and chosen to ignore them. The fact is that a majority of centres do operate the assessment scheme correctly and in the right spirit. The moderators are perfectly happy for such centres to submit high marks for their candidates providing the exercises are valid and have been rigorously marked. The only acceptable exercises are those either from Issue 2 of the Edexcel guide or approved centre-designed exercises. However, the moderators are not prepared to accept submitted work from centres that includes the same shortcomings as in the previous year and that was highlighted on the U9 (now E9) feedback report. Examples of unacceptable work are the use of exercises from the pre-2003 version of the Edexcel coursework guide and the use of centre-designed exercises that have not been approved by the Principal Moderator.

Administration of the scheme.

All of the points listed below have been made in previous Examiners' Reports. They are written in this Report in the hope that they may act as a checklist for centres. Any centre assessor entering candidates for the unit 3 coursework option should be able to answer 'yes' to each of the following questions. If this is not the case then the centre should be aware that it is operating the scheme incorrectly and would be well advised to make some changes with immediate effect.

- Will every candidate have at least one mark from an organic exercise in his or her mark profile?
- Will every candidate have a record sheet (Appendix B) with counting marks circled and the arithmetic checked and correct?
- Are all the exercise used either from Issue 2 of the Edexcel guide? If not, has the Principal Moderator approved them?
- Are the exercises marked in such a way that the moderator may follow the marking? Has accuracy in ability B been awarded by comparing candidates' values with those of the assessor?
- Is ability A assessed under close supervision without the use of books and notes? If candidates word process their plans is this also done under supervision?
- Have you read the U9 report from summer, 2005? If any 'No' boxes were checked on the U9 have you taken action to address the issues raised by the moderator?

Comments on assessment of the abilities

Ability A: Planning

As was explained in detail in the Summer 2005 Examiners' Report this ability must be assessed under supervision. There is no need for candidates to word-process their plans. If they do so then this must be carried out under direct supervision. A note should be included in the sample to the moderator to explain the circumstances under which plans have been word-processed. Parts of AS3 are often badly marked by centres. In order to score marks 1, 2, 3 and 4 the candidate must clearly be describing the preparation of a saturated solution

Ability B: Manipulation

The two ability B exercises should be taken from different types of exercises. AS1 and AS2 are relatively similar in that they both involve carrying out an acid-base titration. A more appropriate combination would be either of AS1 or AS2 and AS4, AS6 or AS7. A new acid-base titration exercise has been issued by Edexcel and may be used for assessing Ability B instead of, perhaps, AS1 or AS2. Copies of this assessment complete with mark scheme and grid can be requested, **by email**, from the Edexcel Assessment Leader.

There appears to be some misunderstanding as to how the marks for accuracy should be awarded in for example, AS2 and AS4. The figures given in the mark schemes are the outside limits of accuracy. For example if a candidate's titre differs from that expected by 0.34 cm^3 then the mark awarded is 3 not 4. In AS4, for a temperature difference of $1.7 \text{ }^\circ\text{C}$ the mark awarded is 1.

Ability C: Observation and recording

In AS9, test 3(a) 'red' alone is enough for the flame colour observation mark.

Ability D: Interpretation and evaluation of experimental skills

In AS12 the wording at the end of the exercise should read " In the spaces provided write your suggested formulae for the functional groups present in W, X, Y and Z". This is the wording already in the mark scheme version of the exercise. Assessors should amend the candidate instruction sheets accordingly

Hints for Revision

- When carrying out a titration swirl the solution in the flask continuously as you add solution from the burette. Add solution from the burette drop by drop close to the end-point.
- Concordant titres differ by no more than 0.20 cm^3 .
- The inference from a flame test should refer to the metal cation not just the metal. eg a lilac flame shows that potassium **ions** are present.
- When one metal displaces another from solution the larger the enthalpy change the further apart the metals are in the reactivity series.
- If when a white solid is heated, it vaporises and reforms higher up the tube it has sublimed. The solid will be an ammonium salt.

Unit 6243/01A (Practical Test)

General

The AS practical test worked well with at least some candidates in each centre gaining the expected observations and values. There were no problems reported by centres concerning the materials supplied by Edexcel. Details of the unknowns are provided as Appendix C.

Question 1

Compound **A** was ammonium chloride.

The expected observation in (a) was that the white solid would reform on the cooler, upper part of the test tube and that the candidates would recognise this as an ammonium salt subliming. However a common incorrect response was to assume that the white smoke observed was hydrogen chloride even though there was no evidence to confirm this.

In (b) almost all candidates recorded that the red litmus turned blue and that ammonia gas was being evolved from an ammonium salt. The stem in (c) was carefully worded in an attempt to make the expected inferences reasonably obvious to candidates. Those who read the question carefully gave both silver chloride and the chloride ion as inferences.

Question 2

The acid-base titration was straightforward and carried out to a high standard by the majority of candidates with most scoring high marks for the accuracy of their mean titre. Although not stated in the procedure it is expected that burette volumes will be read and recorded to the nearest 0.05 cm^3 . Parts (b)(i) to (iii) of the calculations were straightforward and completed correctly by a majority of candidates. Parts (iv) and (v) were more demanding for many candidates with confusion over the use of density in (v). If candidates are unsure as to the accuracy expected in titration calculations they may be advised to work to three significant figures when calculating molar amounts. It was expected that candidates would know that the safe way to prepare a dilute solution of sulphuric acid is to add the concentrated acid to water, with stirring and possible cooling.

Question 3

The sample of ammonium chloride dissolved quickly, with the solution formed cooling. To award accuracy marks the examiners assume that the weighing has been carried out precisely. They multiply the candidate's recorded mass of solute (corrected if subtraction has been incorrectly carried out) by a factor (1.40) to give the candidate's expected temperature change. Accuracy marks are then awarded by comparing the candidate's recorded temperature change with that expected. A common mistake in this part was to ignore the instruction to subtract the higher from the lower temperature. Done correctly this gave a negative temperature change.

Part (b)(i) was usually well answered. In (ii) there was some confusion with units. Either J or kJ was accepted but the units written had to match the calculated heat change. More perceptive candidates gave the molar enthalpy change in (iii) with a positive sign since the dissolving was obviously endothermic. Although the examiners had hoped to see the final calculated answer given to two, or possibly three, significant figures no penalty was imposed in this question for an inappropriate number of significant figures.

Question 4

The planning question was fairly straightforward with the majority of candidates having at least a reasonable idea as to what was required. There were some omissions including a failure to dry the displaced copper. Some candidates stated that the moles of **M** would be equal to the moles of copper sulphate ignoring the fact that this reagent was in excess. Possible reasons for inaccuracy included that the copper may still be damp when weighed or that **M** may have become coated with copper preventing a complete reaction. As ever there were some candidates who, presumably, referred to a textbook and described the experiment to investigate the enthalpy change when copper is displaced from solution.

Hints for revision

- If, on heating, a white solid sublimes it will be an ammonium salt.
- Always record burette volumes to the nearest 0.05 cm³. eg 24.50 cm³, not 24.5 cm³.
- In observation and inference exercises read the instructions carefully and attempt to give the inferences asked for. These may not be the same as in a previous, similar question.
- If the temperature in a reaction falls the reaction is endothermic and its enthalpy change is positive eg $\Delta H = +17 \text{ kJ mol}^{-1}$.
- Be very careful using books or your notes as a reference in planning questions. It is unlikely that you will find exactly the same experiment as that required in the question.

Unit 6243/02

Introduction

This paper was designed to give students the opportunity to think about the significance of what they had seen and carried out in the laboratory. The examiners saw many excellent answers. However, the trend towards the production of answers where candidates appear not to have read the question carefully before they start to write seems to be accelerating.

Question 1

Many candidates scored full marks on this question, which tested knowledge of the reagents used for testing gases and ions. However a significant number failed to read the question carefully and assumed that the salt and S were a single compound, ignoring the inference that the salt contained a nitrate ion. Hence they deduced that S was an ammonium salt and gave 'ammonia', the gas evolved, rather than the reagent used as the answer to the final part. The use of limewater to test for carbon dioxide was well known but a small number of candidates insisted that it was a solution of calcium carbonate and lost the mark. Potassium dichromate was sometimes confused with potassium permanganate and showed a variety of oxidation states for the chromium. The least well answered part was the reagent for the nitrate test where 'ammonia powder' was a common answer.

Question 2

This question was well done by many candidates.

The question starts with a statement with the 'Group 2' in bold. Unfortunately a significant number of candidates gave answers that were Group 1 metal ions. This was one of two places where candidates could have eliminated error by looking at the Periodic Table printed on the back of the paper. The question also asks for the formula of the cations and anion. Large numbers of candidates gave names. The charge on the cations was often +1 and that on the nitrate -2.

This question tested knowledge of the solubility of the sulphates of Group 2 not the trend down the group. The most common wrong answer was Mg^{2+} for a cation with an insoluble sulphate.

The brown gas was identified by most candidates even when no reference to nitrate had been given in the first part of the question.

The confirmation of the identity of the cation was generally by the flame test. This was well know but almost all those candidates who chose magnesium as the metal suggested it had a 'bright white' flame colour. Alternative tests based on the addition of hydroxide ions to a solution of the nitrate were acceptable but rare and when seen were often very confused.

Question 3

This was the best answered question for most candidates. Most showed good knowledge of the tests for functional groups but were again let down by failing to read words such as 'element' in the question.

Part (a) asks for the halogen to be identified. Many candidates sacrificed a mark by writing bromide or Br⁻. Part (b) was very well done by most candidates. Several answers were acceptable for (c), hydroxide, OH⁻, was not one of them and was the usual wrong answer. Candidates should be advised that a wrong answer after a correct one will negate the correct answer. Part (d) presented very few problems. The structures in (e) were well drawn. Candidates have learnt from past reports of the need to show all the hydrogens and make sure the bond goes to the oxygen atom in the OH group. The major error among candidates, who had worked out the chemistry involved, was to give a primary bromoalkane and a secondary alcohol or *vice versa*. This again seemed to show a lack of appreciation of some of the information in the question.

Question 4

The question asked for two straight lines of best fit. The overwhelming majority of candidates performed this test well but a small number drew lines that were curved at the top or joined the points. Some drew lines that only passed through one point on the graph and a few extrapolated the graph back to the y-axis to find the temperature rise.

The question was designed to test candidates' ability to read data from a graph. A surprising number of very good candidates found this task too difficult. Candidates should be advised to check what each square on the graph represents. The main reading errors were to take the x-axis squares as 0.2 cm³ instead of 1 cm³ and the y-axis as 0.4 °C instead of 0.2 °C. This was penalised and the candidates' quoted data was then used to mark the rest of the question consequentially. The most common error was to record the final temperature despite the word change being in bold type in the question.

Part (c)(i) was completed correctly in most cases and the data used properly for the rest of this part. Some candidates insisted on giving wrong units for all parts of this question. Again this can negate a correct calculation answer at this level. Examples included mol dm⁻¹ when the question asked for moles. Candidates would be well advised to look at their answer for a calculation and then ask themselves the question 'does this seem reasonable?' This might suggest that an answer to a concentration of an acid as > 100 mol dm⁻³ might be wrong.

While most candidates did well on (a) to (c) the answers to (d) were often poor. The primary error was the use of the wrong data for the volume of the liquid being heated. Many good candidates pointed out the assumption that the density of the solution was the same as that of water although this was not asked. Common wrong masses were: the mass of acid added; the mass of alkali at the start; and the total mass at the end. For (d)(ii) marks were available for the correct sign and units. Some candidates lost marks because they added per gramme at the end of the units. The calculation required the candidate to think how the data had to be used and this proved a good discriminator.

The final part of the question was well done by most candidates but a small minority suggested that if the reaction was carried out more slowly the results would be more accurate, while others suggested the reaction should be carried out more quickly.

Question 5

Many candidates produced answers that suggested they had not taken time to read the information given at the start of the question and as a result lost marks in the percentage yield calculation through the use of wrong relative molar mass data.

The question in (a) was separated into two parts as a result of previous questions of this type where candidates had failed to give full answers. Most candidates realised that heat was needed to speed up the slow reaction some expressed this in terms of the activation energy of the reaction. Fewer candidates were clear as to why the mixture was heated under reflux, many suggesting it allowed the reaction to go to completion without explaining how refluxing helped to prevent loss of volatile components.

The drawing in (b) showed some improvement on those of previous years. Common errors included putting a (labelled!) bung in the top, having the water going the wrong way round the condenser, having the water inlet and outlet joined to the centre tube of the condenser and drawing a distillation apparatus. Most drawings scored some marks but many did not resemble apparatus seen in laboratories. It raises the issue of whether candidates handle and assemble apparatus any more.

Part (c)(i) effectively required candidates to write in words the second equation in the stem of the question and in (c)(ii) to think about and apply other information given about solubility. In some cases poor quality of written communication meant that (c)(i) proved difficult for some candidates with many writing about neutralisation, the need to produce sodium chloride or 'to act as a catalyst'. In (c)(ii) the indiscriminate use of the words "precipitate", "solidify", "liquefy" made many answers difficult to follow. Many candidates described the dissolved benzoic acid as being a liquid and some thought that it might evaporate while being filtered.

Calculations at this level have shown much improvement over the last few years and the majority of candidates found no problem with this one. A minority divided the mass of acid produced by the mass of ester taken to give a percentage and a small number divided the mass of product by M_r and said this was the yield (~ 2.4 %). Some answers were spoilt by candidates calculating the value of M_r for the compounds (data given in the question) and getting them wrong. A small number of candidates calculated yields of well over 100 % but seemed unconcerned and carried on with the rest of the question.

In (d)(ii) those who realised the connection with (c) scored well, many others were hampered by poor understanding of basic chemical terminology with many suggesting the yield would increase as the reaction would continue.

The conditions needed for the use of phosphorus pentachloride as a test for the -OH group were well understood by the majority of candidates with some excellent answers that suggested because the water also contains the -OH group a false positive would be found. Some thought the ethanol would react with water.

Question 6

It was pleasing to see many candidates have noted comments in previous reports and did not assume they knew which white powder was which and tried to use a process of elimination.

The chemistry to be used was stated in the question as was the need to give the expected result of a test in each case. Much time could have been saved by more careful reading of the question. This was a planning question but most answers seemed to lack any coherent plan.

The question was based on recall knowledge of heat on nitrates and the solubilities of compounds listed in the specification. As always, there were several routes through the problem and all routes received equal credit.

The question clearly stated that the flame test 'cannot be used to identify each of the compounds with certainty'. It was therefore difficult to understand why so many candidates suggested the flame test. Many also tried to prove the presence of nitrate. Many gave experimental techniques when told that these were not required. Methods based on rate tended to break down as it was not clear how this would be measured. A significant number of candidates had the elements in the wrong group, insisting rubidium is in Group 2 despite having a Periodic Table printed on the back page of the paper.

A good many candidates failed to recall the correct chemistry involved in the thermal decomposition and precipitation reactions. For example, a response that cropped up from time to time related to the thermal decomposition method for determining the relative molecular mass of an unknown salt.

The common error in answers, where the candidate had a full grasp of the chemistry and how to apply it, was to omit the need to make a solution before solubility tests could be carried out. Most candidates in this group scored 5 marks out of 6. Almost all candidates started by heating the nitrates and looked for a brown gas but many then said because lithium and rubidium are both in Group 1 neither would give nitrogen dioxide while strontium would. Some went on to explain the reasons for this in terms of polarisation of ions. Those who made the error and then went on to distinguish between lithium and rubidium could still receive full credit for the rest of the question.

Some candidates thought that heating the nitrates would give the metals that could then be added to water and different observations made.

Many of those who correctly differentiated the nitrates by the initial use of heating then became very confused as they tried to distinguish between the lithium and strontium salts.

Hints for Revision

Read the question and look at the data given

- Take time to plan longer answers
- Look at the result of a calculation and think about whether the answer makes sense
- Make sure you can draw simple apparatus
- Practise reading graphs
- Learn the test for ions
- Use the Periodic Table to remind you which group an element is in.

Unit 6244/01

General

This paper had many straightforward questions that all candidates could access, but it was also sufficiently challenging for the most able candidates who were given an opportunity to show the extent of their knowledge and understanding of the course. 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 explain a concept, while other candidates included extraneous contradictory material in their answers.

Question 1

In (a)(i), many candidates were unaware that burning sodium in excess oxygen produced sodium peroxide rather than sodium oxide. By contrast, in (a)(ii), the formation of phosphorus(V) oxide was better known and correctly balanced equations for the combustion of phosphorus were often written. Part (b) proved challenging to many candidates as ionic equations were required rather than full equations. Most candidates knew what amphoteric meant, however, and could gain a mark for showing aluminium oxide reacting with hydrogen ions in one equation and then hydroxide ions in the other. In (c)(ii), the majority of candidates did not appreciate that the hydroxide ion concentration, $[\text{OH}^-]$, was twice $1.31 \times 10^{-4} \text{ mol dm}^{-3}$. Consequential marking, however, allowed credit to be given for a logically correct pH from each candidate's stated hydroxide ion concentration, subject to this producing a pH value for saturated magnesium hydroxide solution of above 7. A sizeable number of candidates confused the expression for the ionic product of water, K_w , with the expression for K given in the question. This led to candidates solving equations involving $[\text{OH}^-]^2$. No knowledge of solubility products was required in order to answer this part of the question. In (d)(i), incorrect state symbols appeared in many of the equations written, despite the information given in the stem of the question. Part (d)(ii) rarely produced full marks. Many candidates realised that barium sulphate was insoluble in water, but did not explain how its formation would act as a barrier to further reaction. A sizeable number of candidates quoted trends in the solubility of the Group 2 hydroxides, including references to changes in the magnitude of the lattice energies of these compounds down the group. The trends in hydration enthalpies of the Group 2 cations were also stated. None of this knowledge was relevant as an answer to the question set.

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)(ii), the structure of the 2,4-dinitrophenylhydrazine derivative proved difficult for many candidates to recall. By contrast, in (a)(iii), a large number of good answers were seen involving either Fehling's or Tollens' reagent. A common omission was the fact that a precipitate is formed when reacting an aldehyde with Fehling's solution. In (a)(iv), a surprisingly high proportion of candidates commented only on the difference in structure between an aldehyde and a ketone, rather than on the reluctance of the ketone to undergo oxidation under the conditions quoted in (a)(iii). In (b)(i), the reagents and conditions for the nucleophilic addition of hydrogen cyanide to a carbonyl compound were recalled better than in previous examinations. Part (b)(ii) proved difficult for many candidates who did not realise that two types of stereoisomerism, geometrical and optical, were present. In (c)(i), reduction was nearly always stated as the correct answer. In (c)(ii), although many candidates realised that the carbon-carbon double bond in compound A would not be reduced by lithium aluminium hydride, they then omitted the carbon atom that had been in the -CN group or drew the -CH₂NH₂ part of the molecule without the hydrogen atoms attached to the carbon atom. Part (d) concerned the preparation and reaction of a Grignard reagent. A lack of clarity of expression led many candidates to suggest in (d)(ii) that the solvent (ethoxyethane) would react with water, rather than the Grignard reagent. A significant number of candidates drew an incorrect alcohol in (d)(iii), but consequential marking allowed a mark to be awarded in (d)(iv).

Question 3

Part (a) proved straightforward for many candidates, although K_p expressions containing square brackets appeared more often than one might expect. This showed that, in some candidates' minds, there is still confusion between K_p and K_c . Examiners saw many excellent answers to the calculation in (b). The steps were well laid out and easy to follow. A significant number of candidates, however, were unable to deduce the number of moles of each component present at equilibrium. Consequential marking allowed the remaining available marks to be awarded in such cases. Surprisingly, a small proportion of candidates introduced their own units into their final answer to the calculation. These units included mol dm⁻³ or Pa. In (c)(i), it was rare to see all three marks awarded as very few candidates firstly established the change in the value of K_p in order to then explain the shift in the position of equilibrium. In (c)(ii), a comparison was required of the colour observed before and after the equilibrium mixture was heated. Many candidates realised this and stated the correct answer.

Question 4

In (a), a significant number of candidates did not define the term enthalpy of atomisation correctly. Many candidates specified that the definition referred to the atomisation of one mole of an element to produce one mole of gaseous atoms. This is not necessarily so, as exemplified by elements such as the halogens. Frequently, the equation given for the atomisation of iodine contradicted the words that had previously been written. A large number of the equations seen gave the state symbol for iodine under standard conditions as (l) or (g). Part (b) was generally well answered, as most candidates were able to construct a Born-Haber cycle for lithium iodide. The correct lattice energy value of -761 kJ mol^{-1} was by far the most usual answer. Consequential marking allowed credit to be awarded for correct arithmetic in cases where an incorrect algebraic expression for the lattice energy had been given in (b)(ii). Examiners frequently 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 (c), many candidates realised that magnesium iodide has covalent character. The importance of clear written communication was highlighted in this question. Examiners saw many contradictory answers, in which the words atom, ion and molecule were used interchangeably. Some candidates failed to mention both the small size and relatively large positive charge of the magnesium cation as the factors responsible for its highly polarising nature.

Question 5

In (a)(i), most candidates were able to draw the structure of the zwitterions correctly. In (a)(ii), it was not always made clear that strong electrostatic forces of attraction existed between adjacent zwitterions. Many answers stated or suggested that the forces of attraction that were broken on melting solid serine were those between the positive and negative charges that were present within an individual serine zwitterion. Also, there were relatively few references to the fact that a large amount of energy is required to break the strong ionic attractions between zwitterions. Parts (b)(i) and (b)(ii) were generally done well. Part (b)(iii) proved more difficult, with the carboxylic acid group often erroneously being esterified. Credit was given for the formation of either the correct ester or the substituted amide (or both). Structures containing chlorine atoms were frequently shown. It was, however, pleasing to see the ester linkage correctly drawn on many scripts. In (c)(i), bonds from a carbon atom to the hydrogen atom in the $-\text{OH}$ group were carelessly drawn. Part (c)(ii) proved more challenging than (c)(i), with often too many atoms being shown in the repeat unit of Terylene. Responses to (d)(i) and (d)(ii) often earned maximum credit. Weaker answers made reference to the formation of acid chlorides or other incorrect products when methyl ethanoate is hydrolysed in the presence of hydrochloric acid.

Question 6

In (a), relatively few of the pH curves drawn warranted full marks. The vertical section of the curve was frequently shown when a volume of 20 cm³ of sodium hydroxide solution had been added, rather than 40 cm³. The mark for the initial pH of the acid (pH = 2.2) was often scored. Conversely, the initial rise in pH when the alkali is first added was overlooked and the final pH of the mixture when excess 0.100 mol dm⁻³ sodium hydroxide solution is present was not accurately represented.

Part (b)(i) produced many perfectly worded answers, although some candidates simply stated that the pH of the buffer “remained constant on addition of acid or alkali.”. In (b)(ii), 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. Surprisingly, the concentrations of the acid and alkali from the titration in (a) often appeared in the expression to calculate the pH of the buffer solution. Part (b)(iii) required the use of equations to explain how the mixture of methanoic acid and sodium methanoate acts as a buffer solution. Candidates, therefore, did themselves no favours by writing answers devoid of any equations. The partial ionisation of the acid and the complete dissociation of the salt could have been shown by writing two equations. Frequently words, rather than equations, were used to explain the effect of adding small quantities of hydrogen ions and hydroxide ions to the buffer solution. The final point in the mark scheme, that the concentrations of the acid and salt were large in relation to those of the added acid or base, was rarely made.

Hints for Revision

- Practise writing ionic equations, for example those showing the amphoteric behaviour of aluminium oxide. Start with full equations, then delete the spectator ions.
- 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 drawing pH curves.
- Practise writing equations which help to explain how a buffer solution works.

Appendix A (STATISTICS)

Mark Ranges and Award of Grades

Unit/Component	Max. Mark (Raw)	Mean Mark	Standard Deviation	% Contribution to award	Number Sat
6241/01	60	34.1	11.2	100	5455
6242/01	60	37.0	10.3	100	3517
6243/01	50	44.2	5.1	50	290
6243/01A	50	36.1	5.7	50	484
6243/02	50	29.5	8.9	50	1368
6244/01	75	41.6	14.2	100	3666

6241/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	44	39	34	29	25
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	31	27
Uniform boundary mark	90	72	63	54	45	36

6243/01 + 6243/02

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	78	71	64	58	52
Uniform boundary mark	120	96	84	72	60	48

6243/01A + 6243/02

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	73	67	61	55	50
Uniform boundary mark	120	96	84	72	60	48

6244/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	53	47	41	35	29
Uniform boundary mark	90	72	63	54	45	36

Advanced Subsidiary award

Provisional statistics for the award (301 Candidates)

Cumulative %	A	B	C	D	E
	16.1	37.1	61.2	81.6	93.6

Advanced award

Provisional statistics for the award (80 candidates)

Cumulative %	A	B	C	D	E
	25.3	49.4	68.4	84.8	96.2

Advance Subsidiary/Advanced UMS grade boundaries

	Max Mark	A	B	C	D	E
Advanced Subsidiary	300	240	210	180	150	120
Advanced	600	480	420	360	300	240

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.

APPENDIX C – online marking (ePEN)

ePEN (electronic Performance Evaluation Network) is an image based marking system available online. ePEN allows the user to mark sections of papers, known as items. Scripts are scanned into the system and divided (electronically) into individual responses which correspond to each item. The responses are displayed on the examiner's PC. Candidates and centres should be assured that the ePEN marking system results in more accurate marking.

The following is offered as a guide to teachers preparing candidates for the exam.

1. Candidates should write their answers in the spaces provided on the question paper. They should be reminded that the mark allocation is more likely to be the best guide on how much to write (not the number of lines or the space provided). If a candidate has more to write than the space allows s/he can:
 - extend the answer beyond the borders or
 - use space on a "blank page" or
 - use space after other questions

Candidates should avoid writing text very close to the spine of the script as the scripts are sliced down the spine before scanning.

The candidate **must** alert the examiner to the fact that there is more of an answer written elsewhere on the script by writing, for example, "see page #" or "see below" or using an arrow to point to the rest of the answer. This will enable the examiner to refer the matter to the Team Leader who can see the whole paper.

An additional answer sheet (or booklet) is only necessary where there is a significant amount of additional writing needed.

2. Candidates must write their answers in dark blue or black ink. Pencil is permitted for graphs and diagrams (and is visible when the script is scanned). Candidates are **not** permitted to use coloured inks (red is still frequently seen). There is no benefit from using coloured inks to highlight different features on an answer. These colours may not scan clearly and in any case the script is scanned in monochrome and hence any differentiation is lost.

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