

# Examiners' Report January 2008

GCE

## GCE Chemistry International (8080/9080)

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## Introduction

This unit seeks to examine a candidate's ability in the basics of chemistry at AS level and to show progression from GCSE. Many students produced excellent answers showing understanding of chemistry and its application. Many, however, have yet to master basic skills of writing equations, setting out calculations and giving concise explanations. Many examiners commented on poor presentation and poor use of English. This is not penalised unless it makes it impossible to understand what the candidate is trying to say or find the reasoned thread in a calculation. Examiners again saw frequent examples of scripts where candidates had chosen to ignore information or directions in the text. Major examples included lack of correct formulae when the formulae were given, use of words not included in the list provided, assigning ionic bonding to a molecule which was stated as being covalent. These errors alone cost some candidates several marks.

## Question 1

A surprising number of candidates were unable to give a correct electron configuration for the copper atom. Many quoted a  $3d^94s^1$  configuration rather than the lower energy  $3d^{10}4s^1$ . A majority of candidates recognised the need to add an electron to the bromine configuration to obtain the bromide; however, some candidates ignored the negative charge or took an electron off. Part (b) was well answered by the majority of candidates; common errors included the omission of the idea of 'average' or 'mean' when describing the mass. Few answers contained any reference to isotopes. Some candidates language skills let them down and references to atoms of carbon weighing 12 grammes were not uncommon. Candidates seem to have learnt from previous papers and few gave the relative atomic mass 'units' in (c). Candidates are still having trouble with the final figure and some still getting to the right answer and then rounding up to 3 sig.figs. even though the question is clear in that it asks for the answer to two decimal places. The examiners were concerned about the number of candidates who obtained answers for the weighted average that were outside the range of the two masses given.

Part (d) proved a good test of candidates' ability to calculate empirical formula as the answer was not obvious. The majority of candidates obtained the correct answer. The main error was the use of the atomic number for copper rather than the atomic mass (but not for the rest!). A small percentage of the candidates calculated the figures correctly and then wrote the wrong formulae or made such a mess of the layout that they could not read their own figures. It was hoped that those who made this sort of error would realise their mistake when they moved on to (ii) and the numbers did not add up. The main error in this part was to fail to make it clear how the numbers were used. Part (e) was well done by the vast majority of candidates but some managed to multiply the figures or ignore the formula given.

## Question 2

In (a) a range of colours for the lithium flame test were allowed and some phonetic spellings of the word lilac. The question was generally very well answered. Part (b) was well answered by most candidates with the ideas of promotion of electrons due to energy absorption and emission of the excess energy in the form of light in the visible region well understood and expressed. However, in some answers it seemed as though atoms were being promoted and very occasionally absorption spectra were

described. Some lost marks because the answer talked about 'colour' being emitted. In (c) the most able candidates scored all three marks and many others were able to score the mark for (iii). But most of the equations were a mystery to many candidates with a significant minority failing to score any marks on the section. This is of some concern as the writing of equations is a basic chemistry skill expected of candidates at this level. Candidates were unable to write the formula of simple compounds such as potassium carbonate even though this was given in the question, had little idea of the formula of nitric acid, or failed to balance any of the equations. Some candidates still change formulae when an equation does not balance or add extra products, in this case  $H_2$ , to make the numbers work.

The question in (d) tried to encourage candidates to think about the possible factors involved in bonding type before they answered the question about covalency in chlorides at the top of group 2. It suggested they should use one route or the other. Some candidates produced clear, concise, well argued answers others chose to ignore the advice and muddled the two ways of looking at bonding. Most candidates used the polarisation route rather than the electronegativity difference (or lack of it in this case) route. In those answers, where the ideas were understood, candidates were able to discuss the size and charge on the beryllium (ion) and the effect this has on the chloride ion. Marks were lost because atoms rather than ions were used; the chloride ion was quoted as able to polarise the beryllium ion; the suggestion that large differences in electronegativity values leads to covalency; ions were given electronegativity. Some candidates were let down by poor language skills. What was not clear was why so many candidates argued the case for covalency perfectly, then drew dot and cross diagrams to show ionic bonding, while others who had little or no idea of the reasons were able to draw correct diagrams showing covalency.

### Question 3

Many candidates were able to score some marks on the bonding/shape diagrams in part (a) and (c)(i) and (ii) but were struggling with the application of ideas to solve the problems posed. Candidates were expected to show at least three water molecules correctly bonded to each other by hydrogen bonds with a linear arrangement across the hydrogen bond and the partial charges on the molecules shown. This is not easy but many were able to draw clear diagrams for the H-O-H molecule and its hydrogen bonds to other molecules and show the partial charges. The angle on the water was well shown but the orientation of the molecules was less good. Candidates could be encouraged to think of the hydrogen as having two bonds to it and like all such systems they will be on either side of the atom. A significant number of candidates tried to draw diagrams with the atoms represented as circles. Many of these were difficult to interpret as they tended to involve at least six or more molecules or were so small the bonding was not clear. The advice is to keep it simple. The most common errors were to describe the bonding in  $HO_2$ , show hydrogen bonds between two hydrogen or two oxygen, or not make it clear which were the hydrogen bonds. A small number of candidates made commendable efforts to show the ring structure in ice. Many of the answers to (b) failed to realise the important factor is the number of hydrogen bonds involved for each molecule rather than their strength. Many of these candidates went on to score the second mark. Some candidates suggested water could form three hydrogen bonds, this was penalised. In some answers it was not clear whether the candidate thought the hydrogen bonds were within the molecules or between them. Candidates who argued that the difference was because water had more electrons and therefore greater van der Waals' forces did not score.

There were large numbers of correct answers for (c) (i) and (ii) with clear shapes shown for the  $\text{H}_3\text{O}^+$  ion and correct angles. Very few candidates were able to suggest simply that adding a positive  $\text{H}^+$  ion to a positive  $\text{H}_3\text{O}^+$  ion would be difficult because of repulsion. Most answers became very involved.

#### Question 4

Examiners were surprised by the number of very poor answers for (a). Ignoring those who chose to disregard the instruction concerning 'oxidation number change' and wrote about gain or loss of electrons and scored zero, there were relatively few clearly expressed correct answers. Many candidates were unable to provide the correct forms of words to be awarded the marks. There were many references to increase/decrease in oxidation numbers without any indication as to which species the change related and where there was reference to the species involved, it contradicted the correct answer. It seemed that poor use of English, rather than lack of chemical knowledge prevented the mark from being awarded, in many cases. The redox equations in 4(b) and (c) proved a good discriminator at the top end of the mark range. Many candidates were able to score the mark for (ii) but not for (i) or (iii). Electrons were frequently omitted in (i), while in (ii) the commonest mistake was to put a chlorine atom rather than (half) a molecule on the product side. Some candidates managed to get the correct overall equation even if one or both of (i) and (ii) were wrong. A majority of candidates were able to score at least one mark in (d). The most common correct observations were the colour of the iodine solid or vapour and the fumes of hydrogen iodide. Most candidates were able to give the correct equation for the thermal decomposition of potassium chlorate(V) in (e). In (e)(ii) candidates were awarded marks for the correct identification of the oxidation numbers of the species changing and linking the changes to oxidation in the case of oxygen and reduction in the case of chlorine. Many candidates scored two marks for a correct interpretation of oxidation number change from incorrect data (often oxygen with an ON = -6). Those candidates who discussed the reduction of potassium from ON +7 to ON +1 or failed to mention oxidation number were penalised. A small proportion of candidates assumed the question was about disproportionation as they often have been in the past.

#### Question 5

Many candidates answered (a)(i) of the question well, scoring both marks. For those who scored one mark the basic idea of attraction for electrons was well understood but the reference to 'within a covalent bond' was omitted. The main errors were reference to 'molecules' rather than 'atoms' or to ionic bonding. In some cases responses indicated that many were more familiar with using a difference in electronegativity rather than fully appreciating the meaning of the term itself. In (a)(ii) many candidates understood the ideas involved and were able to relate the symmetry of the methane molecule to the lack of overall polarity. However, the fact that the electronegativity values for hydrogen and carbon are similar was often given as the reason for the molecule being non-polar. Another example of candidates choosing to ignore the information in the question and thus sacrificing marks. Poor use of English resulted in some candidates being penalised for not making it clear that it was the dipoles or polarities which were cancelling out rather than the bonds. Candidates scored well in (iii).

In general the calculation, in (b), was well done with many candidates scoring highly. The use of wrong units was much less common than in previous papers. The calculation caused some candidates problems because they failed to use the mole

ratios stated in the equation. There were a small number of answers where the candidate used different figures from those in the equation, 5 in place of 25 being the most common. Some candidates have taken note of the need to lay out the answer in a logical way. However some general jumbles of numbers were seen in which it was not always easy to find the final answer. There seems reluctance among candidates to write words in calculations to show what the numbers mean. This can lead to difficulty in awarding possible part-marks.

### Question 6

The definition of first ionisation energy was well known if not always well described. The usual errors of 'one electron from a mole of atoms' and 'a mole of electrons from one atom' were seen, but most candidates were able to score full marks. A simple equation with state symbols can help clarify a written definition but if the equation is wrong (e.g. with  $X^-$  being formed) this will be penalised. In (b) examiners were looking for the factors of shielding, size and increase in nuclear charge to explain the difference between the first ionisation energy of potassium and sodium. Many very good answers were seen. Most of those who score two marks missed the reference to increase in nuclear charge. Some answers discussed effective nuclear charge or suggested that the charge on potassium and sodium were the same (+1). The best answers were the most precise stating that the attraction due to increase in nuclear charge was outweighed by the increase in shielding due to increased numbers of inner shell electrons.

Almost all candidates scored the mark for (c)(i). The main error was those who chose not to use the list of answers provided. Again marks lost for no good reason. The reasons for the high melting point of silicon were well understood by most candidates but many failed to score the second, more demanding, mark. Many covalent bonds are strong but the key is the number that needs to be broken in this case. Errors were most often those involving 'molecules' held by van der Waals' forces or in some cases discussion of carbon! The difference between the melting points of sodium and aluminium was recognised by many candidates as due to the presence of metal ions and delocalised electrons, but relatively few were able to relate the strength of the metal bond to the interaction between the two.

### Hints for revision

- Make sure you have read the question.
- Make sure you note the information and instructions given.
- Do not add extra information e.g. how to do the flame test.
- Calculations
  - i. Check you use the correct data.
  - ii. Think about the use of the space provided in each question.
  - iii. Make sure your reasoning is clearly shown. Linking data together with text is vital.
  - iv. Think about your answer, what are the units? Is it reasonable? E.g. 700g of petrol will need a large volume of oxygen given the reacting ratio of 2 to 25.
- Read your answer to make sure it has addressed the issues raised in the question and does not contradict itself.
- Make sure your writing is easy to read and if you cross things out do it neatly.
- Learn definitions and formulae.

6242/01

## General

The paper contained questions suitable for the full range of candidates; straightforward questions accessible to all candidates and demanding questions to stretch those with higher ability. As in previous years, examiners commented on the poor quality of written communication shown by many candidates and the lack of precision in using scientific terms. Marks were lost because candidates did not explain their answers clearly, through careless errors through not reading the question carefully. Candidates should be reminded that all equations, including ionic equations, should be balanced, that calculations should have clear working and that numerical answers should include the correct unit. Organic structural formulae should be drawn carefully, ensuring that bonds connect the correct atoms. Formulae given should also be unambiguous e.g.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  not  $\text{C}_4\text{H}_{10}$ .

## Question 1

This was a straightforward question, mainly testing recall of the electrolytic extraction of aluminium and many good answers were seen. Some candidates suggested that the main purpose of the carbon anode was to react with unwanted oxygen and the words electrode and electrolyte were often confused. The cathode reaction was generally well done though several candidates lost the mark by giving the state for the  $\text{Al}^{3+}$  ion as aqueous. A sizeable minority did not know the charge on an aluminium ion. Most candidates correctly stated that oxide ions were oxidised due to loss of electrons though several failed to answer the question and name the process. Incorrect temperatures for electrolysis were very common, particularly seeming to relate to the Haber Process. For the role of cryolite, correct answers were less common than incorrect; lowering the melting point of alumina or even bauxite were common misconceptions and it was also commonly believed to be the electrolyte. The properties of aluminium given frequently did not match the use and terms were used casually; corrosive, erode or rust for corrode, light for low density. For power cables candidates failed to emphasise that aluminium must have high conductivity.

## Question 2

Many good answers were seen explaining why the synthesis of ammonia is a redox reaction, but many candidates ignored the instruction to use oxidation numbers and gave general definitions of redox or answers relating to electrons. Candidates had great difficulty in obtaining correct values for the oxidation numbers; nitrogen +3 and hydrogen +3 were particularly common. Candidates often correctly calculated oxidation states but failed to state which was oxidised and which was reduced. Many correct bond energy calculations were seen but only the better candidates explained their working and gave units. Weaker candidates found it difficult to calculate the total bond energies correctly and some confusion with signs was evident. It was clear that many thought they were using heats of formation rather than bond energies. A number of candidates erroneously divided by 2 to calculate the enthalpy change for 1 mole of ammonia. Very few candidates realised that only average bond energies for the N-H bond were relevant here. Heat losses or non-standard conditions commonly cited as the cause of the discrepancy.

Thermodynamic and kinetic stability were well explained by the majority of candidates. For kinetic stability many candidates referred to activation energy being needed but failed to mention that it must be high in this case while many wrote of the reactants having high activation energies. Only a small minority of candidates realised that the high activation energy was due to the high bond energies involved. Many good, well argued answers were seen explaining the factors affecting rate, especially regarding the use of catalysts, but many weaker candidates gave GCSE type answers relating to collision frequency. In discussing temperature a surprisingly large number of candidates omitted any mention of activation energy and many are still referring to the number rather than the proportion of successful collisions. The word "atoms" was frequently used for molecules and "move around more" or "vibrate more" for increased kinetic energy. Despite the hint given, a large number of candidates gave answers which discussed pressure, concentration and surface area effects. A significant number of candidates also wasted time in discussing equilibrium yield and compromise temperatures. Many candidates were able to explain how to increase yield though a significant number of candidates referred to concentration or catalysts and many suggested removal of the ammonia. Le Chatelier type explanations of temperature and pressure effects were much less common than in previous years. Weaker candidates frequently refer to the exothermic side of a reaction rather than the exothermic direction. The separation of ammonia was not well known by the majority of candidates. Fractional distillation without reference to the need for cooling rather than heating was commonly suggested, as were just heating, filtration, dissolving in water. Many candidates suggested that ammonia is more dense and settles to the bottom. Most candidates were able to suggest that unused hydrogen should be returned to the reactor though addition of more nitrogen to, or removal of ammonia from the equilibrium were commonly suggested.

### Question 3

Almost all candidates could name the product and classify the reaction for its formation but the equation was poorly done. Omission of KBr, use of NaOH and use of C<sub>4</sub>H<sub>9</sub> in formulae were the most common errors. While knowing the conditions for the reactions many did not seem to understand the term solvent and named the solution instead. Few candidates seemed to understand what is meant by an ionic equation. Of those candidates who did attempt an ionic equation only a minority could balance it. Many were able to correctly give the alkene formula but commonly omitted the H<sub>2</sub>O. Most candidates could correctly identify the geometric isomers with only a small minority drawing structural isomers. Although a smaller number of candidates than in previous years suggested that the rotation was responsible for the existence of isomers many were still vague about what could not rotate e.g. answers relating to restricted rotation of the molecule. Only a minority of candidates were able to explain clearly the need for two different groups on both the C=C carbons.

Most candidates could identify the hydrogenation catalyst (nickel commonly misspelt), the most common wrong answers were iron and sulphuric acid. A significant minority gave the general answer alkane as the product while a few suggested margarine. Most candidates wrote a correct equation for the reaction of ammonia to produce the amine although HBr was a more common product than NH<sub>4</sub>Br. Many of the candidates who gave NH<sub>4</sub>Br were unable to balance the equation. The amine group was commonly shown at the terminal carbon and C<sub>4</sub>H<sub>9</sub>NH<sub>2</sub> was also fairly common. Correct conditions were rarely given. Candidates commonly suggested heating under reflux or just heat. A sealed tube without heating was also common.

Many correct empirical formulae were obtained but many candidates, having correctly divided by the atomic mass obtained an incorrect final answer by rounding the smallest value obtained (0.779) to 0.77, 0.7 or 0.8 before using it to calculate the mole ratios.

#### Question 4

Many candidates managed to arrive at the correct answer for the enthalpy of combustion though only the better candidates explained how they did so. It is common to see answers such as “products - reactants”. Units were often omitted. Candidates who obtained a correct or an incorrect answer often did so without either drawing an energy triangle or stating the equation they were using. The equals sign is constantly misused. Many candidates drew an energy triangle with arrows drawn in the wrong direction i.e. towards elements (or sometimes even combustion products) rather than from elements. Only the best candidates realised that the only factor that could make the answer very different from the value at 298K is the physical state of water. Most made vague references to non-standard conditions, average values, incomplete combustion, heat loss or theoretical versus practical values. Some referred to the standard enthalpy of formation of O<sub>2</sub> not being given.

In comparing fuels better candidates gave well organised answers clearly organised as advantages and disadvantages. Much more common were rambling answers in which it was often not clear whether the factor being discussed was of positive or negative benefit. Weaker candidates also made references to cost rather than cost per unit of energy and energy rather than energy per gram. The idea of storing hydrogen under pressure or as liquid did not occur to the majority of candidates and many referred to the dangers posed by its flammability. Several suggested that hydrogen would be light to carry. Environmental references were often unspecific without naming the greenhouse gas, carbon dioxide, or making it clear that hydrogen produces only water (rather than less CO<sub>2</sub>) as a combustion product. Many appear to think that CO<sub>2</sub> is a toxic gas.

Many good candidates gave names, flow charts or equations showing oxidations as an addition to their answer. Weak candidates produced some very strange molecules, many containing tri- or pentavalent carbons. The general standard of formula writing was poor so it was sometimes difficult to be sure which atoms connected to which. If candidates decide to scribble out atoms or bonds they would be well advised to redraw the whole formula and cross out the original.

Most candidates correctly drew a tertiary alcohol though some lost marks by drawing general rather than specific examples. Fewer candidates could correctly name the alcohol they drew e.g. methylpropan-2-ol was frequently named as a pentanol, ethanol or methanol derivative. A surprising number drew secondary or primary alcohol structures.

The catalyst was usually correctly identified though NaOH was a common suggestion. Most candidates correctly drew the repeat unit for polythene though repeat units with too many carbons or with a double bond were often seen. Most candidates could suggest a simple use for polythene though its use in the manufacture of plastics was not uncommon.

## Hints for revision

- Learn the details of conditions and equations involved in the industrial chemistry within the specification.
- Learn examples of the uses of particular polymers and metals named in the specification and relate the uses to specific properties.
- Practise writing balanced equations, particularly ionic equations and half equations.
- When practising enthalpy calculations pay attention to explaining what you are doing and give due attention to the direction of arrows, signs and stoichiometric quantities.
- Practise writing organic structural formulae carefully, ensuring that bonds connect the correct atoms and that the formula you give is unambiguous e.g.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  not  $\text{C}_4\text{H}_{10}$  for butane.
- Learn to read the question carefully and confine your answer to the question e.g. if the question asks about rates do not include a discussion of yield.

## 6243/01A (Practical Test)

### General

The exercises included in the practical test all worked as expected, at least for some candidates in every centre. For home centres the accuracy of a candidate's mean titre and temperature change was judged by comparing their values with those of the examiners. For International Centres the examiners rely on the values provided by the centre supervisor.

Many candidates either misunderstand or chose to ignore the requirement to give numerical answers to an appropriate number of significant figures. It is worth explaining to candidates that when an answer is rounded to three significant figures any trailing zeros should be included as appropriate.

### Question 1

Compound A was ammonium chloride.

In (a) a common observation was to record steamy fumes then to infer that these were hydrogen chloride. The intention of heating ammonium chloride gently was to observe some white solid re-forming on the upper, cooler, part of the test tube then to infer that sublimation was occurring.

Since the question asked for the suggested identity of the cation in A the response of ammonium chloride was not given credit. Most candidates did correctly record that the red litmus turned blue in (b) but, surprisingly, did not always identify ammonia as the gas. Even though the question instructed candidates to shake the test tube when adding ammonia in (c) many candidates failed to observe that the white precipitate dissolved. The expected inference was chloride ion not ammonium or silver chloride. Credit in (d) was given for answers that either gave an example of an anion destroyed by nitric acid or by those that stated in more general terms that "interfering anions" are destroyed.

### Question 2

It continues to be an expectation of the practical test that burette readings are recorded to a second decimal place and, preferably, to the nearest  $0.05 \text{ cm}^3$ . This requirement includes the mean titre. The accuracy expected for maximum marks to be awarded was within  $0.30 \text{ cm}^3$  of the expected value. This more generous range was used because candidates had to both carry out a dilution and a titration in this exercise. Parts (i) and (ii) of the calculations in (b) were generally correctly carried out. In (iii) candidates were required to scale the amount of hydrochloric acid calculated in (ii) to give a concentration in  $\text{mol dm}^{-3}$ . Very many candidates missed the point that the amount of HCl in  $250 \text{ cm}^3$  of D was originally contained in  $25.0 \text{ cm}^3$  of the original acid solution. In (c)(i) some candidates failed to realise that the hydrochloric acid, not sodium hydroxide was now in the burette.

### Question 3

Although almost all candidates measured and recorded three temperatures in (a) arithmetical errors were made when calculating the temperature change. In (b)(i) the mole calculation was almost always correct. There were numerous errors in (ii) and (iii) of the calculations. The mass of solution to be used in (ii) was 50 g. The calculated heat change in (ii) was in joules unless it had been converted into kilojoules by dividing by 1000. The negative sign to show an exothermic reaction was commonly omitted in (iii). A calculated answer of, for example, 56.848 should have been rounded off to two significant figures and written as  $-57 \text{ kJ mol}^{-1}$ . Of the many modifications suggested in (iv) the most likely ones to be useful and effective in practice were the use of a pipette instead of a measuring cylinder and adding a lid to the polystyrene cup.

### Question 4

Many excellent and high scoring plans were seen. Most of these described a method in which the volume of carbon dioxide was measured then converted into moles. Further calculations were described to find the amount of hydrochloric acid then its concentration. Some plans omitted to include that the volume of gas should only be recorded when the reaction was seen to be finished. Plans that relied on calculating the amount of calcium carbonate reacting had to make allowance for the fact that some would remain unreacted at the end. This was perfectly possible if its mass was measured before and after the reaction. In this case the pieces of calcium carbonate would have to be washed and dried before re-weighing after reaction. Some plans relied on a method in which the hydrochloric acid was titrated against a solution of calcium carbonate forgetting that the compound is insoluble in water.

#### Hints for revision:

- In observation-inference questions make sure that you give the exact inference asked for. If you are asked to identify the anion present in a solution that gives a white precipitate with silver nitrate you should answer chloride ion not silver chloride.
- Burette readings and mean titres should be given to the nearest  $0.05 \text{ cm}^3$ .
- When you calculate a heat change include units with your answer otherwise it may not be clear whether you are working in joules or kilojoules.
- If you use both blue and red litmus paper in a test only one will change colour.

## 6243/01 (Coursework)

### General

Almost all of the centres with candidates for this session had previous experience of the scheme. It is pleasing to report that the feedback provided to centres over the past few years has resulted in a gradual improvement in the way in which the scheme is administered. Most of the candidates were assessed thoroughly and fairly. They carried out an acceptable range of exercises that allowed their teachers to award marks that reflected the laboratory skills of each candidate. It remains the case, however, that a few centres fail to implement the assessment scheme in the correct manner. The moderators can only assume that the teachers from such centres have either not read, or have chosen to ignore, the detailed instructions in Internal Assessment of Practical Coursework for AS GCE Chemistry (8080) booklet issue 2 (January 2003). A letter listing some amendments to a few exercises in the booklet was sent to centres in September 2003. A summary of these amendments has been included in at least two Examiners' Reports. The most important points from the letter are repeated below.

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

Centres that have received E9 reports with no negative comments may assume that they are implementing the scheme correctly and that their marks will not be altered. Those centres with reports that list some shortcomings need to take action to address these.

### Comments on the administration of the scheme

There follows a list of points (all of which have been made in previous Examiners' Reports) that some centres need to note and then take immediate and appropriate action.

- Record cards are no longer valid Edexcel documents. They have been replaced with record sheets. A copy of the AS record sheet is on page 36 of the 2005 Examiners' Report. This is available on the Edexcel website under Chemistry GCE at [http://www.edexcel.org.uk/VirtualContent/48112/8080\\_9080\\_rep\\_sum05.pdf](http://www.edexcel.org.uk/VirtualContent/48112/8080_9080_rep_sum05.pdf)
- The sample of work sent to the moderator should include only the work for each candidate that has counted towards his/her total mark. The moderator will not look at any work that does not fall into this category.
- It is obvious that some candidates, presumably supported by their teachers, think that a word-processed plan is likely to be awarded a higher mark than one that is hand written. This is simply not the case. The vital requirement for ability A is that candidates complete their plans under supervision and without reference to notes, books or web sites. If word processing can be carried out under supervision then this is acceptable to the moderators. If word processing is used to make a neat copy of the original hand written plan, with corrections, then this practice is completely unacceptable and, indeed, is a breach of the regulations covering coursework.

- Teachers now commonly use numbered ticks. This practice is greatly appreciated by the moderators since their use makes it easy to follow the award of marks, especially in a planning exercise.

#### Comments on the assessment exercises.

- More centres are using the supplementary exercise AS15, an acid-base titration, for the assessment of ability B. This is a straightforward exercise and is recommended. The exercise is available from the Edexcel coursework department at [coursework@edexcel.org.uk](mailto:coursework@edexcel.org.uk)
- It is most helpful to the moderators if the value of a titre or temperature change against which a candidate's value may be compared for accuracy is written alongside the candidate's value.
- It remains a requirement of the scheme that every candidate must have a mark for an exercise based on organic chemistry included in their total mark.
- The two ability B exercises used in the total mark should, as far as possible, test different laboratory skills. Acceptable combinations of ability B exercise include AS2 (or AS15) and AS4; AS1 and AS7; AS1 and AS6 (or AS7).

#### Summary

The moderators thank centre assessors, technicians and candidates for making the January assessment scheme run so smoothly.

The 8080 scheme will operate unchanged for candidates in the summer of 2008.

#### Hints for revision

- Record a mean (average) titre to the 2<sup>nd</sup> decimal place even if this is a zero. eg 24.50 cm<sup>3</sup> not 24.5 cm<sup>3</sup>.
- When you mix two solutions and a solid forms record this as a precipitate not a suspension or cloudiness.
- The precipitates formed when silver nitrate solution is added to a solution of a halide are either white (AgCl) or cream (AgBr) or yellow (AgI). There is no need to use any other descriptions of the colours apart from these.
- When starch solution is added to a solution and a blue-black colour is seen this shows that iodine is present not iodide.

6243/02

## General

The January 2008 paper was broadly comparable to the previous papers in the series testing similar skills and offering a range of opportunities to score marks and discriminating effectively at all grades. The Quality of Written Communication was tested by giving opportunities for extended transactional writing, questions requiring short but precise answers and in calculations benefiting those candidates who set out their responses clearly and logically. While there were many excellent responses which showed a keen awareness of the practical dimension of this paper, the answers of quite a number of candidates suggested limited first-hand knowledge of some of the basic experimental techniques required by the AS course especially those used in Organic Chemistry. Many candidates were unable to express their answers to a prescribed number of significant figures, with confusion between, significant figures, decimal places and the number of digits being widespread; the truncating of numbers was quite common as was the practice of rounding intermediate values in calculations.

### Question 1

The colour change required in (a) was well-known but only the better candidates could identify the gas required in (b)(i), hydrogen chloride and ammonia were common suggestions. While most candidates were aware of the behaviour of primary, secondary and tertiary alcohols which formed the basis of (b)(ii) and (iii), few were able to identify the specific compounds unambiguously: attempts at systematic names were often inaccurate or showed unfamiliarity with the basic rules of nomenclature while abbreviated structural formulae omitted brackets and full structural formulae omitted atoms. Weaker candidates gave aldehydes and ketones as their answers. Only the better candidates knew the purpose of the aluminium powder in alkali and even these often identified the gas formed as nitrogen dioxide. While there were many excellent descriptions of a flame test, it would appear that some candidates are unfamiliar with the technique. The purpose of the acid in the test seems not well understood and quite a number of candidates substituted the hydrochloric acid with concentrated sulphuric acid. Even some good candidates gave elaborate and unnecessary descriptions of cleaning the flame-testing wire.

### Question 2

While most candidates were aware of the general procedure required to prepare a standard solution, only the stronger candidates adapted their method to ensure that the entire sample of sodium carbonate was used, as required in (a). The best candidates were able also to formulate a clear logical sequence which included all the essential details. However, a number of candidates seemed quite unfamiliar with the standard glassware used and solutions were prepared in conical flasks, beakers and weighing bottles. The calculation in (b) was successfully completed by most candidates but few were able to express their answer correctly to three significant figures, and candidates typically gave their answer to three decimal places and some just three digits (i.e. 0.09). Very few candidates at any level knew the colour change of methyl orange at the end-point but most were able to correctly select the accurate titres for the calculation of the mean value. There were many excellent answers to (c)(iii), the most usual error being to use the number of moles in  $250\text{cm}^3$  rather than  $25\text{cm}^3$ . Weaker candidates transposed the volumes required for the calculation or omitted factors of a thousand and offered highly implausible answers uncritically.

### Question 3

Few candidates were able to demonstrate a sound knowledge of the standard techniques used in preparative Organic Chemistry required in (a), to explain features of the procedure described or to use sensibly the data provided. In (a)(i) candidates frequently cited the possibility of vigorous, dangerous or explosive reactions and even those who correctly deduced that an exothermic reaction was occurring often believed that it involved the sulphuric acid and water. Most candidates scored well on the reflux diagram and were aware of the need to keep the condenser open; however, the quality of some of the drawing was disappointing, with freehand sketches, unlabelled diagrams and open water jackets being quite common. Most candidates suggested that a difference in density rather than immiscibility was essential for separation using a separating funnel. While candidates were usually able to suggest a suitable safety precaution, many were unable to articulate the reason; candidates often transformed the hazard information on 1-bromopropane to 'harmful to the skin'. The yield calculation in (b) was very well executed by all but the weakest candidates and the reasons for yields of less than 100% were well known.

### Question 4

While good candidates recognised the purpose of the titration in the procedure described at the start of question 4, the use of generic responses such as 'to determine the concentration of the acid' was very common. In (a)(ii) the benefit of allowing the temperature to equilibrate to room temperature were generally appreciated but weaker candidates often gave answers which related to the situation when the reaction was complete. The calculations in (b)(i) and (b)(ii) proved challenging for most candidates. In (b)(i) the most common error was use of the incorrect mass of solution with 25 g, 22.75 g and 1.0 g all being tried; some candidates also added 273 to the temperature change and others gave units of  $\text{Jg}^{-1}\text{K}^{-1}$  for the heat produced. The calculation of the number of moles of water produced was the part of the (b)(ii) calculation that was most likely to be wrong although a significant number of candidates were unable to convert a heat change into an enthalpy change and also many who did not include the sign of the enthalpy change. In (c) a number of candidates simply reiterated the assumptions about density and specific heat capacity given at the start of (b)(i).

### Question 5

There were some excellent experimental plans described in response to question 5, showing a clear understanding of the essential principles coupled with an appreciation of the key practical issues; the best candidates understood that there was no need to calculate the enthalpy change for the reactions as this would be directly proportional to the temperature change. Most candidates appreciated that a series of displacement reactions was needed but the omission of the stirring of the mixture while measuring the temperature and a lack of clarity about the use of the data collected were quite common errors. Many candidates failed to give their answers sufficient preliminary thought resulting in illogical sequences and complicated insertions in the middle of their method; such difficulties were often compounded by over-elaborate procedures, including detailed descriptions of basic techniques such as weighing, and lengthy accounts of cooling curves although all that was required was to place the metals in an order of reactivity. Weaker candidates described procedures involving preparing the salt solutions, filtering and weighing precipitates or mixing the different solutions. These answers were often characterised by a casual use of technical vocabulary, particularly the use of element and compound names as synonymous.

**Hints for revision:**

- Check that you can express numerical answers to a specified number of significant figures and make sure that you understand the difference between significant figures and decimal places.
- Practice drawing neat, accurate diagrams of the apparatus used in standard chemistry experiments. Remember that these diagrams should be in cross-section.
- Ensure that you understand the basic rules to be followed when drawing the structures of and naming simple organic compounds.
- Practice writing out practical procedures in a logical order and using concise language.



6244/01

## General

This paper had many straightforward questions that all candidates could access, but it was also sufficiently challenging for the most able students 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

Parts (a) and (b) provided many candidates with a sound start to the paper. In (c)(i), candidates were required to write a balanced equation for the neutralisation of phosphoric acid with sodium oxide. Assigning a correct formula for sodium phosphate proved troublesome in a significant number of answers, although a correctly balanced equation showing the formation of sodium hydrogenphosphate or sodium dihydrogenphosphate was accepted. In (c)(ii), water was often omitted as a product of the reaction. Part (d) proved challenging to many candidates as ionic equations were required rather than full equations. Most candidates knew what amphoteric meant, however, and could recall correctly one of the two equations. The requirement, written in the question in bold, to include state symbols was frequently overlooked. In several instances, the state symbol for aluminium oxide was given as (aq) rather than (s). In (f), the relative stability of the +2 and +4 oxidation states was known by the majority of candidates, although there was sometimes confusion as to which species were oxidised and which were reduced in the reaction between tin(II) ions and iodine.

### Question 2

This question proved to be challenging in a variety of ways. In (a), often only one of the two functional groups present in each of compounds Y and Z was identified and the ester group in compound X was frequently identified as a carbonyl group. In (b), a significant number of candidates realised that compound Z would undergo oxidation when reacted with alkaline ammoniacal silver nitrate solution. Many responses, however, showed the free carboxylic acid, rather than the carboxylate anion, as the organic product of the reaction despite the alkalinity of the reaction mixture having been mentioned in the question. In (c), all five marks were rarely scored. In (c)(i) and (ii), the formula of only one of the two organic products was given in each case, namely sodium propanoate and triiodomethane, respectively. In (c)(iii), the correct response was frequently seen. If an incorrect structure was drawn, it was usually because an -OH group had been omitted from the formula or an incorrect number of carbon atoms had been shown in the carbon chain. It is worth pointing out that the bond between a carboxylate anion and a sodium cation should not be represented as a covalent bond ie  $\text{-COO}^- \text{- Na}^+$ .

### Question 3

Part (a) proved to be challenging. The idea that the reaction has to be stopped or quenched, so as to maintain the equilibrium concentrations of reactants and products, appeared unfamiliar to many. A significant number of candidates thought that rapid cooling was used either to prevent glass tubes from breaking or to condense the gases before determining the iodine concentration. Examiners saw many excellent answers to the calculations in (a)(ii) and (b)(ii). The steps showing the necessary working 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 in (b)(ii). Consequential marking allowed the remaining available marks to be awarded in such cases. In (b)(iii), a significant proportion of candidates introduced units of  $\text{mol dm}^{-3}$  into their explanation as to why  $K_p$  for the reaction given had no units.

### Question 4

In (a)(ii), the majority of candidates did not realise that  $\Delta H_5$  showed twice the first electron affinity of hydrogen on the Born Haber Cycle given and so it followed that the first electron affinity of hydrogen was therefore  $\frac{1}{2}\Delta H_5$  rather than simply  $\Delta H_5$ . Part (b) was generally well answered, with a standard enthalpy of formation value of  $-186 \text{ kJ mol}^{-1}$  by far the most usual answer. In (c), the importance of clear English was highlighted when answering this question. Examiners saw many contradictory answers in which the words atom, ion and molecule were used interchangeably. The first two marks in the mark scheme, nonetheless, were often awarded but the fact that the magnitude of the lattice energy is a reflection of the strength of the interionic attractions in the lattice was not made. A substantial number of candidates thought that magnesium hydride and calcium hydride both contained hydrogen ions,  $\text{H}^+$ , rather than hydride anions,  $\text{H}^-$ . Part (d)(i) yielded many correct answers for the definition of enthalpy of hydration, but correct explanations for (d)(ii) as to why the enthalpies of hydration of cations and anions are exothermic were far less frequent.

### Question 5

In (a)(i), the relatively new format provided for candidates to identify the two conjugate acid-base pairs proved to be highly successful with candidates and examiners alike and many correct responses were seen. In (a)(ii), 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. Part (b) elicited many very good responses. In (b)(i), however, the denominator occasionally included an extraneous  $[\text{H}_2\text{O}]$ . In (b)(ii), it was necessary to deduce the value of  $[\text{H}^+]$  given the pH and this appeared to be an unfamiliar step for many candidates. Having calculated a value for the propanoic acid concentration, many candidates stated the first assumption in the mark scheme that  $[\text{H}^+] = [\text{CH}_3\text{CH}_2\text{COO}^-]$ , but a realisation that the degree of dissociation of the weak acid is negligible eluded a significant number of candidates. In (c), only a minority of candidates could explain the phenomenon of salt hydrolysis by use of an appropriate equation and many answers stated that “the pH of the salt solution produced is alkaline because this is a weak acid-strong base titration.” In (d)(i), a significant number of candidates gave a correct definition of the term buffer solution, although some candidates simply stated that the pH of the buffer

“remained constant on addition of acid or alkali.” In (d)(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, but consequential marking allowed subsequent marks to be awarded.

### Question 6

In (a)(i), most candidates were able to draw the structure of the zwitterion correctly, showing all bonds. The positions of the positive and negative charges were not always correctly shown in the zwitterion. In(a)(ii), many candidates wrote that a hydrogen atom, rather than ion, protonated the amine group,  $\text{-NH}_2$ , to form the zwitterion. In (a)(iii), 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 glycine were those between the positive and negative charges that were present within an individual glycine 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), (ii) and (iv) were generally done well and it was pleasing to see the ester linkage correctly drawn on many scripts in (iv). The formation of the substituted amide in (iii) was found more challenging by the majority of candidates. Some near-miss answers included nitrogen atoms forming four covalent bonds in the product or organic structures which included chlorine atoms,  $\text{-Cl}$ . Part (c)(i) was well answered, with more than one correct response frequently given. In (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. The fact that the isomers rotated the plane of polarisation in opposite directions was all that was required. In (d), most candidates were able to identify the two monomers correctly.

### 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.
- Practise writing ionic equations, for example those showing the amphoteric behaviour of aluminium oxide. Start with full equations, then delete the spectator ions.
- Practise working out the relevant concentrations of acid and salt in a buffer solution.
- Read the question carefully. Then answer the question set.



6245/01

## General

This paper contained a number of straightforward items that most candidates could attempt, but there were also some more demanding items to challenge the more able candidates. Many candidates achieved high marks for some of the questions, with question 2 being the most challenging. Many candidates found the electrochemistry items difficult but the majority could complete the titration calculation in question 5.

This paper does contain some of the synoptic assessment and it was disappointing to see that many candidates seemed unfamiliar with some of the basic concepts from the AS course.

## Question 1

Although the majority of candidates were able to complete the electronic configurations for chromium and its ion, there were some who included 2 electrons in the 4s orbital of the atom and 1 in the ion. The shape of the hexaaquachromium(III) ion was generally well known, with just a few candidates describing it as hexagonal. The explanation for the shape was not always made clear, with only a minority of candidates referring to the repulsion between the six bonding pairs of electrons. Most candidates knew the colour of the chromium(II) hydroxide precipitate and that it dissolves to form a green solution in excess aqueous sodium hydroxide. The equations for the reactions were less well done, with unbalanced equations given or incorrect charges on the precipitate and complex ion.

The majority of candidates could give an example of an organic oxidation reaction, although some candidates lost a mark as they increased the number of carbon atoms in the product formula, for example, showing that ethanol is oxidised to propanoic acid. Part (b)(ii) was the most demanding part of this question. Many candidates were able to calculate the  $E_{cell}$  values for the two oxidising agents reacting with chloride ions, although some mixed the equations and wrote equations with chlorine. Only the most able candidates could then deduce that because the reaction between manganate(VII) ions and chloride ions is feasible to produce chlorine, hydrochloric acid cannot be used to provide the hydrogen ions, and vice versa for dichromate(VI) ions. The majority of candidates realised that the oxidation state of chromium remains at +6 in the reaction in (b)(iii), so it is not a redox reaction. Some candidates described the reaction as just oxidation or reduction.

## Question 2

A large number of candidates were able to answer (a)(i) correctly, although some omitted to describe the acids as concentrated and some very high or low temperatures were quoted. An answer such as 'below 55°C' was not given any credit as this could mean any temperature below that value. Candidates should be encouraged to quote one particular temperature or a small range of temperatures and not to qualify them with words such as 'less than' or 'more than'. Some candidates gave an excellent mechanism for the nitration of benzene, with clear structures and curly arrows starting and finishing in the correct places. Others gave an unbalanced equation for the formation of the electrophile, showed a negative charge on the  $\text{NO}_2$ , had carelessly drawn curly arrows, too many positive charges on

the intermediate and, if they used the hydrogen sulphate ion, often had the arrow starting on the hydrogen atom rather than the oxygen.

Some candidates gave excellent answers to (b), but there were many who did not know the reducing agent used in this reaction and others described it as electrophilic substitution.

Many candidates lost a mark in (c) by writing  $\text{NaNO}_2$  and  $\text{HCl}$  as the reagents. They should realise that  $\text{HCl}$  is hydrogen chloride gas and if they mean hydrochloric acid they should write the name or use (aq) as a state symbol. The temperature was usually known, although the previous point made about 'less than' also applies here. The name benzene diazonium chloride was not well known. Candidates were asked to name compound X, so diazonium ions is not sufficient.

Part (d) proved too demanding for many candidates. There were some excellent answers seen in which candidates had thought through their answer and described a logical sequence for the experiment and results. Unfortunately there were too many candidates who started with one method, for example, collecting the nitrogen in a gas syringe, then suddenly changed tactic and plotted a graph of concentration against time, with no explanation of how to convert volume of product into concentration of a reactant. Many candidates realised that if the half lives of the reaction were constant then they could prove that the reaction is first order, but a significant number thought that measuring one half life would also prove this. Candidates should be encouraged to write about experimental procedures in a logical sequence; a list of numbered points would have been suitable here. There were many acceptable methods of carrying out this experiment and dealing with the results. The examiners tried their best to give credit to the highest scoring method the candidate chose.

### Question 3

A significant number of candidates decide to ignore the axes that had been labelled for them in (a) and reversed the diagram by changing the x axis to increasing mole fraction of propan-1-ol or just drawing the curves as if that was the x axis but not changing the labels. Candidates should realise that if they are given labelled axes they cannot score full marks for that question if they change them. Many candidates lost a mark by not labelling the liquid and vapour areas of the diagram and there were some inaccurate curves drawn with minima or maxima.

Although some candidates gave a very clear description of how fractional distillation is used to separate the mixture, many ignored the starting mole fraction of 0.75, drew incorrect tie lines on their diagram and generally gave very muddled descriptions. Some good candidates gave good general descriptions of how to separate a mixture, but they did not score full marks as they did not apply their knowledge to the specific mixture in the question.

#### Question 4

Nearly all candidates knew that fats are esters. The majority of candidates could give an example of a cis isomer, but not all of them could explain why it is cis (rather than trans). It was very disappointing to see so many incorrect answers to (b)(ii). The majority of candidates showed a lack of understanding about what happens during melting and stated that less energy is needed to break the  $\pi$  bond in unsaturated fats rather than the stronger  $\sigma$  bond in saturated fats. A few answers referred to the stronger van der Waals' force in saturated fats, but stated it was due to more atoms. It was rare to see a completely correct answer mentioning the different packing of the molecules due to their shapes.

Some candidates were unfamiliar with the hydrolysis of an ester into a carboxylic acid salt and an alcohol, so they could not complete (c)(i) correctly. Many unusual answers were seen to (ii), such as breaking up fat in the body, but candidates should be made aware of the manufacture of soap.

There were many excellent answers to the chemical test to distinguish between the pairs of compounds in (d). Some candidates ignored the instruction 'other than the use of indicators' and chose litmus or another indicator in (i). Quite a number of candidates did not realise that 2-methylpropan-2-ol is a tertiary alcohol and chose reactions of primary and secondary alcohols, such as oxidation, which do not work here. They should be encouraged to draw out the structures of the molecules so that they are clear about the functional groups present. Part (ii) was answered extremely well by the majority of candidates as there were many acceptable tests they could choose from. Some candidates chose to give more than one test to distinguish between each pair. If both tests worked, they still received full credit. However, if one test was correct and then they described an additional incorrect test, they lost marks.

Similar comments apply to the mechanism in (c)(i) as to the mechanism in question 2. Candidates should think about what is happening during each step so that they can be more precise when drawing the structures and curly arrows. Many candidates confused themselves in (c)(ii) as they thought that  $[H^+]$  decreases when the pH is lowered.

#### Question 5

Many candidates need to revise electrochemistry more thoroughly. A significant number used an iron electrode in the  $Fe^{3+}/Fe^{2+}$  half-cell and only included one of the ions in the solution. There were some good answers to (a)(ii) but allowing the flow of electrons is not acceptable. The solution in the salt bridge was often well known, but candidates should realise that it must not react with any of the solutions in the half-cells, so sodium hydroxide is not suitable. Part (iv) proved challenging for many candidates as they needed to think how to change the calculation they know to work out an emf into one to calculate a standard electrode potential. Although many candidates did write the correct half-equations in (v), some reversed them both and others seemed to include every possible combination of the four species present with electrons often on the wrong side of the equation. Many candidates were unable to write a correct half-equation in (b), with some answers omitting electrons, some using oxide ions instead of oxygen gas and others not realising that hydroxide ions cause phenolphthalein to turn pink. It was very encouraging to see the majority of candidates scoring full marks for (c), with clearly explained and correct calculations for this titration experiment.

## Hints for revision

- Read the questions carefully and do not alter the information given in the question, particularly axes for graphs.
- Learn organic mechanisms thoroughly. Make sure you understand what is happening to the electrons during each step of the mechanism and practise drawing the structures and curly arrows accurately.
- Learn about electrochemical cells - how to measure an emf, calculation of emf or standard electrode potential, how to write half-equations.
- Make sure that you understand what is happening when melting occurs.
- Learn the reagents and conditions for organic reactions accurately.

6246/01A

## General

The A2 practical test contained familiar elements, with the quantitative component being a redox titration of manganate(VII) ions against nitrate(III) ions. The two unknowns were basic copper(II) carbonate and a ketone, which candidates determined to be pentan-3-one from the tests and the spectra provided. It was noticeable that interpretation of the non-coupled proton nmr spectrum was poorly understood by a significant minority. With the organic qualitative there was once again plenty of evidence of the drawback of an open-book exam. Candidates have analysis schemes before them and slavishly copy without thought as to information and other evidence provided in the stem and previous tests. This will continue to be penalised. The titration worked well and many candidates completed the calculation correctly. The observational question was answered correctly by some, although the effect of this reaction on the titration was not. The planning question was broken down into three parts meaning that the actual *plan* accounted for only four of the six marks. The open book nature of the exam was again in evidence here as some candidates tried to adopt or copy plans from earlier papers.

## Question 1

The colour of compound S clearly places the cation within it into the d-block, and this provided two marks for the majority of the candidates. Heating the compound to decomposition successfully gave carbon dioxide and hence carbonate (or hydrogencarbonate) as an inference. Too few candidates recorded the blackening of the residue. Poor observational skills or simply poor recording shown here. The compound dissolves with effervescence, but many candidates added too much acid rather than allow the first few drops to react before adding any more. The green solution was thus only seen by a small percentage of candidates. The subsequent reaction with aqueous ammonia was the clue to copper(II) chemistry, and correctly observed by many. A common misinterpretation was to assign nickel(II) here as many candidates failed to carry out the instruction to add ammonia solution until there was no further change.

The oxidation of iodide to iodine by copper(II) ion is used in the quantitative analysis of copper by iodimetric titration, and many candidates scored well here. The brown colour of the iodine is masked initially by the white precipitate of copper(I) iodide, but the latter soon settles out revealing the colour of the solution above. Too many candidates seem to be too hasty in trying to record their observations, with therefore attendant inaccuracies. The formula for S was correctly given by many as were the oxidation numbers.

## Question 2

The precipitation with 2,4-dinitrophenylhydrazine set all candidates off with carbonyl chemistry, and the majority recognised that failure to be oxidised indicated a ketone rather than the aldehyde. It was here that the penalty of analysis schemes was seen as candidates introduced lists of other functional groups that would be resistant to reaction in this situation. They may have not read the stem in which compound P was stated as containing one functional group.

The  $m/e$  value of the molecular ion was correctly given by the large majority, but wrong answers were often baffling: 49; 100; 60 being seen. Understandable wrong answers included 57 (the base peak) and 83 (a misreading of the scale).

The low resolution proton nmr showed only two signals, and the reason for this was often correct, although clumsily stated. The combined information of the wet tests and spectra should have concluded with pentan-3-one as the identity of the unknown, and many gave this, although there was clearly some lack of understanding in evidence. The value of  $m/e$  was often obtained as a stand alone mark for many who then failed to carry this information forward to the structure. The peak areas and the relationship of these to the structure was often well answered.

### Question 3

The quantitative question involved the redox reaction in which nitrate(III) ions are oxidised to nitrate(V) with manganate(VII) in acidic solution. This requires the former to be placed in the burette, and the exercise worked very well. The technique is one learned for AS and candidates achieve well in this type of practical work. The calculations were left without a guiding structure, but at A2 most candidates found their way through successfully. However, candidates are reminded of the need to consider the number of significant figures that are appropriate in their final answers. The test to investigate the effect of reversing the titration proved demanding, with only a small percentage of candidates observing the effect and then making appropriate conclusions.

### Question 4

The formula  $C_9H_{12}$  does not conform to the general formula for alkanes, so is unsaturated. Candidates also recognised the low C:H ratio as evidence for unsaturation. There were many answers that were simply too vague: for instance “contains a double bond” which indicates that candidates misread the question and gave a general observation about the *nature* of an unsaturated molecule rather than offer an interpretation of the formula. The plan was often well answered, but common errors arose from the open-book nature of the practical test since some candidates clearly copied from a previous test which contained a similar question but with a different outcome. The structure was correctly drawn by many, but some really bizarre offerings were recorded. It is clear that some candidates can complete the exercises under instruction and with guidance from schemes, but actually know little chemistry.

### Hints for revision

- Look carefully at the results of the qualitative tests and record faithfully.
- Add sufficient reagents as instructed and allow these to react fully before attempting to make conclusions.
- Take care not to introduce spurious functional groups into a molecule when there is no evidence.
- Think about the appropriate number of significant figures for *final* answers
- Write clear plans that a peer could follow.

6246/02

This synoptic paper offered a wide variety of chemistry for candidates to consider, and there were many who gave accurate and comprehensive answers. There were some questions that challenged the best, and others that enabled those of more modest abilities to emerge with credit.

#### Question 1

Candidates often knew the theoretical parts of this question rather well, but were unable to cope with the more practical aspects. The reaction between ethanoic acid and ethanol, and the reasons for using sulphuric acid, were often known even by weaker candidates.

The apparatus was often poorly drawn even when correct, and candidates perhaps underestimate the need to practise drawing. The examination should not be their first experience of drawing a distillation apparatus. When they have drawn it they need to be certain that it will work, so they must see where the molecules have to go when moving around their apparatus. In particular the molecules must not need to know where to go!

Many candidates could calculate the percentage yield in the reaction. Many also knew the equation for the reaction of ethanoyl chloride and ethanol and that it was not an equilibrium reaction and gave a good yield.

The understanding of the reasons for the various steps in a recrystallisation was poor, even with candidates who were better overall. Few recognised the need for high solubility in the solvent at the boiling temperature but low solubility at room temperature, saying simply that the solubility should 'increase with temperature'. The use of 'with temperature' to mean 'with an increase in temperature' is also best avoided. The hot filtration is to remove insoluble impurity; however many did not refer to the insolubility at all. Similarly the removal of soluble impurities in the next two steps was not widely appreciated, 'impurity' only being mentioned. Many did know that a melting temperature determination followed by comparison with existing data was needed in the last part.

#### Question 2

Many candidates did not read the question carefully enough concerning the structure of solid sodium chloride, instead giving an answer about its bonding. Thus references to 6:6 co-ordination were uncommon, and many drawings did not extend far enough to allow this idea to be seen.

The solubility of NaCl in water was often mentioned in terms of the interactions between ionic charge and the dipoles in water, but sadly very few went on to talk about the energetics of the process by comparing the magnitudes of the hydration and lattice enthalpies.

Many candidates gave clear answers to the quantitative part of this question, though there were some who produced a correct answer from poorly-labelled Hess's Law cycles. These need to be drawn with some care, and candidates who omitted state symbols in particular were disadvantaged.

Many were able to give the correct products from sodium bromide electrolysis, though some offered bromine as one of the other products. The correct equation for the oxidation of bromide ions was frequently given, with very few candidates suggesting that bromine is Br.

Many candidates gave clear and accurate mechanisms for the addition of bromine to ethene with the proper use of curly arrows. There was a minority of correct answers, however, that were rather poorly written and which needed some decipherment. A few candidates gave the mechanism for the addition of hydrogen bromide to ethene.

Only the relatively few candidates who saw clearly that a mixture of bromine and sodium chloride contains electrophilic bromine but no electrophilic chlorine were able to explain the absence of 1,2-dichloroethane from the reaction between ethene, bromine and NaCl. In the absence of this understanding there were many answers based on ingenious, but sadly irrelevant, differences between bromine and chlorine. Among these were oxidising power, radii, bond strengths, activation energies, and several other ideas too.

### Question 3

Numerous candidates were able to derive convincingly the orders of reaction for the kinetic investigation, and clearly understood the data and used the correct experimental pairings. It was pleasing to see that so many could deal with the slightly more involved data in this question. Others, however, tried to use experiments A and C to get the order with respect to the halogenoalkane. They ignored the fact that the concentration of hydroxide ions has also changed and that at that moment they do not yet know that the order with respect to hydroxide ion is zero. Very few gave the orders with no justification at all.

There were large numbers of correct  $S_N1$  mechanisms in the answers to the second part of the question. The comments earlier concerning poor drawing also apply to some extent here as well. Very few candidates gave the incorrect  $S_N2$  mechanism.

Almost everyone identified the chiral carbon correctly in citronellal, and many went on to describe tests for the two functional groups correctly. It is expected that the colour change for bromine is mentioned. A significant minority offered 2,4-dinitrophenylhydrazine as a test for an aldehyde; this was ignored if candidates then went on to use Fehling's solution or Tollens' reagent, but it is not acceptable on its own.

A satisfying number of candidates knew that  $\text{NaBH}_4$  would reduce the aldehyde group but not the  $\text{C}=\text{C}$  bond in citronellal, and many also added HBr to the molecule with the correct orientation.

Many candidates correctly calculated the volume of  $\text{CO}_2$  generated by the burning of 1 gram of citronellal, though in the equation for the combustion the amount of oxygen was incorrect. Since this does not affect the remainder of the calculation many incorrect equations led to an answer that scored three marks out of the four available.

#### Question 4

Many candidates found the question on the melting points of silicon, phosphorus and sulphur very difficult. In some cases this was because the candidate had no real idea what the structures of phosphorus and chlorine actually are, but mostly it was because there was little attempt to distinguish between inter- and intra-molecular forces. It was often unclear whether a covalent bond was meant, or a van der Waals' force. Most knew that silicon is giant covalent, and for a considerable number that was the end of their ideas. Many answers then managed to skirt around the fact that phosphorus and chlorine are small molecules, and few referred to  $P_4$  or  $Cl_2$ . Candidates need to get their ideas in order before they start to write and in particular must be prepared to offer detailed answers in structural questions.

Many candidates knew the shapes of  $PCl_4^+$  and  $PCl_6^-$ , although fewer knew that this derived from repulsions between electron pairs. Perhaps because there are no lone pairs in these molecules some referred to repulsions between chlorine atoms instead. Numerous candidates did not realise that the name of a specific alcohol or carboxylic acid had to be given together with its reaction with phosphorus pentachloride. Thus a generic 'alcohol' or an equation using ROH was not acceptable for full credit. Many candidates successfully calculated  $K_p$  for the equilibrium given, showing the steps in their calculations clearly. This was an encouraging set of answers; however for some weaker candidates it represented a considerable proportion of the marks gained on this question.

The question on the neutralisation of phosphoric(V) acid was not widely understood. Hardly anyone was able to correctly write the equation asked for, and the areas of the curve that represent a buffer were not widely known.

#### Hints for revision

- Look very carefully at the reasons for each step in a preparative method, so that you know exactly why the various operations are being used.
- Practise drawing apparatus in section. Do not attempt a sketch of a photographic or 3D representation. Remember that molecules do not know where to go!
- Be careful with the use of curly arrows in mechanisms. They represent the movement of a pair of electrons and the way in which electrons move is quite precise.
- In extended answers assemble your ideas before you begin to write. Be exact in the use of terms such as intra- and inter-molecular.
- Make sure that you are answering the question asked and not one that you have seen in a previous paper. In question 2(a) the structure of sodium chloride was asked for, not its bonding.
- In a mechanism it is a good idea to write intermediates out again. Thus when bromine and ethene react, write the step that gives the carbocation; then write the carbocation again and show the attack by  $Br^-$  on this species separately.

## Appendix A Statistics

### 6241/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	60	42	36	31	26	21
Uniform boundary mark	90	72	63	54	45	36

### 6242/01

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

### 6243/01 cwk + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	78	71	64	57	51
Uniform boundary mark	120	96	84	72	60	48

### 6243/01A + 3B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	71	64	58	52	46
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	78	71	64	57	51
Uniform boundary mark	120	96	84	72	60	48

### 6244/01

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	75	54	48	42	37	32
Uniform boundary mark	90	72	63	54	45	36

### 6245/01

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

### 6246/01A + 6B

Grade	Max Mark	A	B	C	D	E
Raw boundary mark	100	75	69	63	57	51
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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