

# **Chemistry**

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

## **Report on the Units**

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**June 2009**

**3882/7882/MS/R/09**

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Reports should be read in conjunction with the published question papers and mark schemes for the Examination.

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### **Advanced Subsidiary GCE Chemistry (3882)**

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# Chief Examiner's Report

## General comments

This June session was the last large entry for the A2 units within the old 'legacy' specification. With new AS candidates entering for the new units, F321, F322 and F323, the entry for the legacy AS units was much reduced, being made up solely of re-sit candidates and candidates taking the full A level qualification in a single year.

The large re-sit candidature performed better than the previous cohorts dominated by candidates in the first year of their Chemistry A level study.

The core units, *Unifying Concepts and Trends and Patterns* had the largest entries. The entry for *Chains, Rings and Spectroscopy* contained a significant number of re-sit candidates from January 2009.

The most popular optional unit continues to be *Transition Elements*, followed by *Biochemistry* and then *Methods of Analysis and Detection*.

The standard of candidates' responses continues to improve. It was significant that Candidates are especially improving in their response to 'stock' questions based solely on specification content. In contrast, the same candidates would often struggle with application-based questions based on some very basic chemistry. So whilst candidates may be well able to calculate the pH of a weak acid and describe how a buffer solution works, the same candidates can struggle to write even simple formulae such as those for ionic nitrates. Structure and bonding continues to create problems, especially when candidates need to choose the correct type of bonding, particle or structure. More worrying is to see ions become electrons and then atoms in the same sentence.

The old legacy AS units, 2811, 2812 and 2813 will no longer be offered for future examination sessions. From January 2010, these units will have been replaced entirely by the AS units in the new specification, F321, F322 and F323.

For January and June 2010 only, all A2 legacy units will continue to be offered to allow re-sit opportunities for candidates completing the A2 course this year. A level aggregation for 7882 will be available in both January 2010 and in June 2010. **There is no facility to mix and match units from the old legacy units and those making up the new specifications.**

Further details of the new specification and changes to assessment arrangements are available from the OCR web site:

[www.ocr.org.uk/qualifications/asa\\_levelgceforfirstteachingin2008/chemistry\\_a/index.html](http://www.ocr.org.uk/qualifications/asa_levelgceforfirstteachingin2008/chemistry_a/index.html)

# 2811 Foundation Chemistry

## General comments

This session was the last opportunity for candidates to re-sit AS units. As such, most, if not all, candidates could be A2 candidates attempting to improve their grade. This was certainly confirmed by the high standard of the papers. Many of the candidates appeared to be aiming for an a, b or c grade necessary for their entry to university. There were very few weak or unprepared candidates.

## Comments on individual questions

- Q 1 Most candidates understood the meaning of 'isotopes', even if they found it difficult to put into words. Similarly, they could work out the number of protons, electrons and neutrons in the isotopes of sulphur. The definition of relative atomic mass was very well known. Most could calculate the relative atomic mass from the data given. Marks were lost as a result of calculator errors, slips when transferring numbers and a failure to give the answer to 4 significant figures. Most knew that the mass spectrometer was used to determine isotopic abundances. Part (b) started with a more challenging question and few identified the water of crystallisation, many believing that it meant a solution. The molar mass was well calculated, but surprisingly many could not work out the oxidation number of sulphur or the formula and charge for the sulphate ion.
- Q 2 The definition of ionic bonding was well known and most could draw the '*dot-and-cross*' diagram for magnesium chloride. There were a few electron transfers and a very few covalent molecules. Only a small minority could not work out the electron configuration. Metallic bonding was not as well known, although most candidates picked up a mark for delocalised electrons. The commonest error was another description of ionic bonding. Few could explain why aluminium had a higher melting point than magnesium. The explanations for cobalt's position in the Periodic Table were good, but less could explain its relative atomic mass, other than a bare 'it has more neutrons'. The calculation was surprisingly well answered, confirming a numerate candidature. There were a few incorrect ratios.

- Q 3      Candidates completed the boxes well, the most common error being  $\text{Ba}(\text{NO}_3)_2$  in **D**. Empirical formulae calculations presented no problem. The equation and explanation in part (c) were familiar territory and produced some excellent responses. The candidates did find explaining the difference in the trends down Groups 2 and 7 more difficult, but the better candidates coped well. Halogen displacement equations are now well understood. Many candidates gained both marks from a correctly balanced equation.
- Q 4      The candidates were obviously delighted to find this as their final question. There were a lot of very high marks. The most common errors were those of omission and contradiction.

## 2812 Chains and Rings

### General comments

The paper produced a good spread of marks with the marks ranging from 1 to 57. Very few scored below 15; equally the top 3 or 4 marks were elusive. This distribution showed a similar pattern to the January 2009 paper, consisting almost entirely of re-sit candidates.

Each of the five questions was accessible to all candidates but each question contained parts that stretched most candidates. Candidates attempted all aspects of the paper. The majority of candidates seem to have been well prepared. Candidates displayed good examination technique in all of the questions and there was no evidence to suggest that candidates ran out of time.

### Comments on individual questions

Q 1 Overall most candidates scored well with just over 7/10 being the norm. Parts (a) and (b) were well answered but a substantial number lost the mark in (b)(i) by showing the amine functional group as  $\text{NH}_3$  rather than as  $\text{NH}_2$ . The nucleophilic substitution mechanism in (c)(ii) discriminated well with able candidates scoring all 3 marks and the weakest often scoring 0.

Q 2 (a) (i) was an easy mark for most, although a substantial number (approximately 20%) confused structural isomerism with stereoisomerism.

In (a)(ii) it was pleasing to see that a large number (40%) scored all 3 marks for drawing isomers. As in previous papers this type of question discriminated well.

Naming, 1,1-dichloropropene, in (a)(iii), proved challenging, with only around 50% scoring the mark.

(a)(iv) was well answered with many deducing a correct dichlorocyclopropane.

In part (b) it was apparent that almost all candidates knew about *cis* and *trans* isomerism. Had candidates been asked to draw *cis-trans* isomers, marks would probably have been awarded. However, when asked to explain in words why some alkenes have *cis-trans* isomers and other alkenes do not, only a small minority scored both marks.

- Q 3 Part (a) was well answered with most scoring 2 out of 3. In (iii), many found 2,2,3-trimethylbutane difficult to draw.

Part (b) was also well answered with many scoring all 6 marks. Clearly the majority of candidates know the free radical substitution mechanism very well.

Part (c) was a difficult question that required careful thought and logic. Very few correctly deduced both parts and the majority resorted to a random guesses ranging from 3 to 23.

- Q 4 The molecular formula of menthol was one of the most difficult marks on the paper. Many candidates wrote the molecular formula as  $C_{10}H_{19}OH$  rather than as  $C_{10}H_{20}O$  and it is worth reminding candidates that molecular formulae should always be written in the format ' $C_xH_yO_z$ '. It was disappointing that a substantial number of candidates failed to interpret the skeletal formula correctly. (a)(ii) was well answered.

Parts (b) and (c) discriminated well with less than half scoring all 8 marks. The dehydration of menthol in (b)(i) generally resulted in either 2 marks or no marks. Many seemed not to recognise that 'hot concentrated sulphuric acid' was a dehydrating agent. Part (b)(ii) scored better with most recognising that an ester would be formed. The reagents, conditions and expected observations for the oxidation of menthol were well known but around half were unable to construct a balanced equation for this oxidation. Almost all scored the final mark for explaining how infra-red spectroscopy could be used to show the absence of menthol.

- Q 5 The question produced a range of responses with marks from 0 to 18 but no candidate scored all 20 marks.

Part (a) was familiar territory but was very open ended. It required candidates to structure their own response whilst at the time addressing the specific points in the question. Many spent a long time discussing fractional distillation in great detail; others described the three refining processes without writing any equations.

Part (b)(i) was poorly answered despite (ii) being well answered. In part (c) many only produced one alcohol and failed to show that both propan-1-ol and propan-2-ol could be formed.



## 2813/01 How Far? How Fast?

### General comments

The general standard of the responses seen was very high and many candidates gave answers that showed real understanding of the chemical concepts involved. This understanding was demonstrated in logical, well reasoned explanations and in solutions to calculations that showed relevant working.

Some marks were lost when candidates did not actually answer the question as set and, in spite of the generally good understanding highlighted above, some concepts still proved somewhat problematic. Examples of these difficulties are given below.

### Comments on individual questions

#### Question 1

- (a) (i) Apart from a few candidates who did not apparently interpret 'process' and stated 'exothermic', this was well answered.
- (ii) This equation was generally known.
- (b) (i) Most candidates gave a correct definition. The phrase 'under standard conditions' was accepted but, if candidates actually quoted conditions, these had to be correct.
- (ii) Not surprisingly, candidates who drew a cycle were more likely to give correct responses. Some candidates appeared to be trying to calculate the enthalpy change of combustion rather than of formation.

Ans  $-279 \text{ kJ mol}^{-1}$

- (iii) This diagram was generally correct but candidates should take care that the lines showing  $\Delta H$  and  $E_a$  are clearly labelled and actually start and finish at the correct enthalpy level.
- (c) (i) Apart from a few candidates who appeared confused between rate of reaction and equilibrium position, most answers were correct and well explained.
- (ii) Explanations were also generally good in this answer but, since the question specifically asked for the sign of the enthalpy change, full marks were not given unless this was stated.
- (iii) This required the application of le Chatelier's principle and many candidates realised the significance of the excess steam in terms of moving the equilibrium towards the desired product.

#### Question 2

- (a) Nearly all candidates clearly knew the formula to calculate the energy produced but many used an incorrect mass. This was most commonly 200 but 1 was also seen in a significant number of cases.

Ans 22.7 kJ

- (ii) Many candidates realised that it was necessary to calculate the number of moles but a significant number tried to use masses. The answer was then credited if they went on to use this number of moles. Few candidates included the negative sign in the final answer.

Ans.  $-56.8 \text{ kJ mol}^{-1}$

- (b) The equation for neutralisation was generally correctly given.
- (c) This is an example, highlighted above, where very few candidates appeared really to understand the reason for the difference in enthalpy change of neutralisation. Nearly all correctly stated that the strong acids were completely dissociated and the weak one was not but then nearly all answers were based on the number of available hydrogen ions rather than on the need to use energy to break the bond.

### Question 3

- (a) Some candidates ignored  $-272$  for the overall enthalpy change of the reaction but many well-explained answers were seen

Ans.  $242 \text{ kJ mol}^{-1}$

- (b) Many correct equations were seen. The most common errors were producing 2 moles of product, using F as the formula of fluorine or omitting all/some of the state symbols.
- (c) (i) Many correct answers were given but some candidates showed they were not really addressing the situation in the question when they described breaking a Cl to Cl bond or a Cl to S bond.
- (ii) Nearly everyone included 'homo' in the type of catalyst and many were correct. There were however a number of other words given with the same prefix – homogenous, homologous, homolytic were all seen.

### Question 4

Many completely correct answers were seen with explanations that showed good understanding of the concept. When drawing two curves on a diagram, candidates should ensure that they clearly indicate which is which.

### Question 5

- (a) Although a few candidates did not write an equation and some candidates incorrectly used hydrochloric acid, most answers were correct.
- (b) (i) Apart from some incorrect formulae for magnesium nitrate the equations were generally correct.
- (ii) Most candidates correctly described bubbling in some acceptable way.
- (iii) Since ionic equations have often not been well done in the past, it was encouraging to note how many correct equations were given.
- (c) (i) In the context of the question the significance of ammonia as a base was generally recognised.

*Report on the Units taken in June 2009*

- (ii) It was evident that most candidates knew how to calculate the percentage. This meant that any errors were usually arithmetic or failure to read the relative atomic masses correctly.

## **2813/02 AS Coursework**

### **General comments**

Just over 500 candidates from about 100 centres submitted coursework for this final session of the AS examinations. Candidates' plans were generally more coherent than has been the case in the past and they included much of the appropriate detail. The moderators were pleased to find fewer errors in the recording of results and in the use of significant figures in the calculations performed.

In the Planning exercises, most candidates were able to carry out any relevant calculations but many failed to provide instructions that could be followed without some amendment to the suggested procedure being made. Although it did not result in the loss of marks, very few seemed to appreciate that a mass such as 0.3 g of copper carbonate would be better heated in something smaller than a 250 cm<sup>3</sup> conical flask. Where an indicator was required, it was not uncommon for the instructions to give the reverse colour change from the one that would be observed.

The Implementation task was usually well answered although the presentation of the results often left something to be desired. There were still too many candidates who just stated the volume used for a titration rather than recording the initial and final volumes of solution in the burette which is, of course, what they actually read.

Although there were some numerical slips in the processing of the results of an experiment, very few candidates seemed to be confused as to the method that should be employed.

The Evaluation of experiments is a difficult skill to acquire and it still proved to be the biggest hurdle for all but the best candidates. There was much discussion of failings more related to carelessness than in fundamental weaknesses of the experimental procedure being followed. Dirty equipment should have been washed before being used and the spillage of solids and solutions should have been avoided as a matter of course. These cannot be given credit as improvements to the method being used. It was felt that not all the candidates had received enough practice to appreciate what was expected in the Skill E assessment.

## 2813/03 How Far? How Fast? (Practical Examination)

### General comments

As almost all of the candidates sitting the examination in this session were A2 candidates re-sitting the examination, there were relatively few very poor scripts.

### Comments on individual questions

**Plan** The general standard of Plans was somewhat disappointing. Probably this is a reflection of the fact that they were re-sitting the examination. Many candidates did not describe the precautions needed for an accurate result when washing soda was heated to drive off its water of crystallisation. The gas collection method was described rather better, and it is encouraging that many candidates showed calculations that justified the quantities of materials used for their experiment. The ability of many candidates to do this has been an area where definite progress has been made during the lifetime of this Specification.

**A**

**Test B** **Part 1** Hydrated barium chloride decomposes without any 'spitting', so the experiment gave rise to very high marks for accuracy. Most candidates presented their results clearly, though some had the normal difficulties with consistency of significant figures. The question on safety proved more challenging than expected, because a number of candidates were led astray by the water of crystallisation in  $\text{MCl}_2 \cdot 2\text{H}_2\text{O}$ . The theory that 'water makes it toxic' was not an uncommon suggestion.

**Part 2** The relatively straightforward calculation was carried out very well by most candidates, and barium was commonly identified from the relative atomic mass obtained.

**Part 3** This test was carried out competently by most candidates. It was disappointing, however, that so many answered 'AgCl' in (a)(ii).

**Part 4** The evaluation section was, perhaps, more demanding than usual. The quality of answers showed that so many candidates find it very difficult to think logically about this aspect of their practical work. Although (b), (c) and (d)(i) were generally answered quite well, other sections were not.

In (a), by far the most common answer was 'to prevent spitting', even though it should have been obvious to candidates that there was no spitting in this experiment. In (d)(ii) many candidates did what the question specifically forbade, by repeating ideas from earlier questions. Few mentioned use of a desiccator while cooling (even when they had mentioned this precaution in their Plan), and surprisingly few discussed reduction of the percentage error in their weighings.

## 2814 Chains, Rings and Spectroscopy

### General comments

This paper produced a very good range of marks with many centres clearly preparing their candidates very well. Many candidates demonstrated a thorough knowledge and understanding of the ideas covered in the specification and it was pleasing to see a good number scoring high marks. Teachers should be congratulated on their efforts and had obviously made good use of the published mark schemes to help prepare their candidates.

### Comments on individual questions

#### Q1

- (a) Most candidates were able to draw the sodium salt of ibuprofen and suggest a suitable base or sodium metal to form it from the acid.
- (b) This part proved to be slightly more challenging as candidates had to identify a 2-halopropanoic acid, a suitable halogen carrier and complete the equation to produce the hydrogen halide as well as ibuprofen.
- (c) The chirality of ibuprofen and the possible disadvantages of having both isomers were well described by the majority of candidates. They did have to apply their understanding to the question and identify the chiral centre in the compound somehow.

#### Q2

- (a) This part tested a range of chemistry and distinguished those with a comprehensive knowledge of the reactions of nitrogen compounds in the specification.
- (b) Many candidates identified phenol as necessary to create the azo dye, but a few omitted the alkaline conditions. Most of those who had identified phenol were able to go on and draw the correct structure of the azo dye from the amine given in (a). However, a triple bond between the nitrogen atoms was sometimes seen.
- (c) The mechanism of nitration was generally well known, although some candidates lost marks through incorrect formulae appearing in the equations or imprecise use of the curly arrows in the last part.

#### Q3

- (a) This part required candidates to draw a correct skeletal formula from the given structural formulae of the two repeat units. It was a novel exercise to draw a skeletal formula of a repeat unit, but many correct answers were seen although a common error was to leave out the 'end bonds'.
- (b) Candidates had to explain addition in terms of the breaking of C=C or no other products and explain condensation as involving the loss of H<sub>2</sub>O or other small molecule.
- (c) The majority of candidates were able to draw the correct structures of benzene-1,4-dicarboxylic acid and propan-1,3-diol. A few lost a mark for poor connectivity to the OH groups.
- (d) Some centres had prepared their candidates well and all the marks were scored by two correct labelled 3-D diagrams. However other candidates struggled with the direction of the 3-D bonds, or left out H atoms to give ambiguous structures.
- (e) Very few candidates had problems identifying that C=O and C-O bonds would be in PTT and were able to look up the correct ranges in the *Data Sheet*.

**Q4**

- (a) Another well-answered question by many candidates who knew this mechanism well and were careful to include all the details asked for in the question. As with the nitration mechanism, it was imprecise use of curly arrows or charges that caused some to lose marks.
- (b) This part again discriminated those candidates who knew their organic chemistry well. Any suitable reducing agent was allowed to form the amine, while any named aqueous acid or alkali could be used for the hydrolysis. If  $\text{LiAlH}_4$  was chosen as the reducing agent, then a non-aqueous solvent, such as ether, needed to be specified.

**Q5**

- (a) Many candidates knew that ammonia was needed to form the amine from the halogenoalkane, although some omitted the necessary ethanolic solvent or high pressure needed to get the nucleophile concentrated enough in non-aqueous conditions.
- (b) Almost all candidates correctly drew the zwitterion of alanine, and many could draw the dipeptide. However, some did forget to show water as a product in their equation.
- (c) This part proved more challenging with some candidates showing more than one repeat unit. A suitable aqueous acid or alkali needed to be identified for the hydrolysis of the peptide. The hydrolysis could also have been carried out using a suitable protease enzyme, although very few candidates chose this method.
- (d) Although candidates were not used to applying their understanding of n.m.r. to amino acids, a good number were able to use the information given to deduce that there would be two peaks in  $\text{D}_2\text{O}$ ; one for the  $\text{CH}_3$  and one for the CH protons. However some candidates did not state that the relative peak areas would be 3:1.

**Q6**

- (a) Most candidates identified the phenol group as the likely cause of the antiseptic properties of the ester.
- (b) A good number of candidates identified the correct structures of salicylic acid and phenol for the first mark, although some omitted water as a product in the equation.
- (c) This proved to be the most challenging question on the paper. Some candidates identified the phenol and salicylate ion as the products of the alkaline hydrolysis. However there were very few who also spotted that the phenol groups would also be ionised in the alkaline conditions. The equation had to be balanced with  $3\text{OH}^-$  to produce  $2\text{H}_2\text{O}$  to gain full marks.
- (d) This part proved to be familiar territory for well-prepared candidates who had a good knowledge of the explanation for the activation of the benzene ring. In the first part they had to identify the reaction as substitution and then suggest any 2, 4 or 6 substituted chlorophenol for the likely cause of the bad tasting water.

**Q7**

- (a) Most candidates were familiar with the use of Tollen's reagent to identify an aldehyde and then the use of the melting point of the 2,4-DNPH derivative to identify the particular carbonyl compound. A few candidates chose other non-spectroscopic methods, such as measuring the boiling points of the aldehydes. These were acceptable as long as candidates identified how they would use the result to distinguish the two compounds.
- (b) Although this question was based on an unfamiliar reaction, many candidates applied the information given and were able to suggest suitable carbonyl compounds that would form the two alkenes. Some did however lose marks through incorrect naming of the products.

- (c) A pleasing number of candidates were able to deduce that a dialdehyde would be produced from a cyclic alkene in this reaction, although a few put the double bond at the wrong position in the ring.

Q8 This final question gave candidates the opportunity to find their way through a more open-ended spectroscopy problem and use the information given to identify the unknown compound. The first three marks were allocated for deducing the molecular formula from the % composition data and molecular mass that could be found from the mass spectrum. They then had to identify the group responsible for each peak on the n.m.r. spectrum. It was not sufficient to give all the options listed in the *Data Sheet* for a given chemical shift, as the peak areas allowed elimination of the ones with the wrong number of protons. There was a further mark for those who explained the splitting of at least one of the peaks in terms of the number of protons on the neighbouring carbon. The mark for Quality of Written Communication was awarded if candidates used at least two of the technical terms (singlet, triplet, etc.) to describe the splitting patterns. The final two marks were allocated to the correct identification of an ester and ethyl ethanoate in particular.



## 2815/01 Trends and Patterns

### General comments

The whole mark range was covered from 1 to 45. There was very little evidence that candidates ran out of time and many candidates wrote at length in the final question.

As in previous sessions, many candidates did not use chemical terminology with precision although there was a little improvement over previous examination papers over the use of the terms atoms, ions, molecules, compounds and elements; and confusion over polarisation and polarisability.

Candidates generally did not lay out calculations in a structured way and so confused themselves with a multi array of numbers. Significant figures were not considered by quite a large number of candidates. Factors of dilution were not well understood.

Candidates found the long question on the complex ions of copper and iron much more accessible than previous long questions and there was good understanding and recall demonstrated by many candidates.

### Comments on individual questions

#### Question 1

In part (a), a significant number of candidates named the second electron affinity as second ionisation energy and the process for the enthalpy of formation was given as the lattice enthalpy equation. Candidates also tended to omit state symbols for some of the species in the equations.

In part (b), candidates frequently discussed standard conditions or experimental errors rather than the difficulty of obtaining gaseous ions without them reacting first.

In part (c), the relative sizes of the oxide and carbonate ions was well known but some candidates thought that the oxide ion had a larger charge than the carbonate ion. Candidates tended to relate this simply to a stronger bond rather than the explanation of stronger electrostatic attraction between ions. Commonly there was confusion between the terms ion, atom and molecule. Also some candidates discussed the polarisation of the carbonate ion by the barium ion and as such did not address the question.

In part (d), many candidates appreciated the fact that polarising power is dependent on charge density but then went on to reverse the order of polarising ability of the ions. Popular misconceptions included: ionic radius increasing from  $\text{Na}^+$  to  $\text{Al}^{3+}$ ; the ionic radii of  $\text{Na}^+$ ,  $\text{Mg}^{2+}$  and  $\text{Al}^{3+}$  being identical.

#### Question 2

In part (a), in (i) many candidates appreciated that the bonding was ionic but the giant or lattice structure was sometimes omitted.

In (ii) the 'dot-and-cross' diagrams were well drawn but the charges proved to be difficult. Popular misconceptions included:  $[\text{Na}]_2^+$ ,  $[\text{Na}]_2^{2+}$ ,  $\text{Na}^{2+}$ .

In (iii) the equation and subsequent explanation were well known.

In part (b) (i),  $\text{H}_2\text{SO}_4$  was a popular incorrect response.

In (b) (ii) the structure of  $\text{SO}_2$  was well known but many candidates thought the bonding in  $\text{SiO}_2$  to be ionic or intermediate. Of those candidates who correctly described  $\text{SiO}_2$  as giant covalent many went on to incorrectly discuss intermolecular forces.

### **Question 3**

In part (a), the numbers of moles of manganate(VII) and hydrogen peroxide were frequently calculated correctly but the working back through the dilutions to arrive at the concentration of the concentrated hydrogen peroxide in  $\text{mol dm}^{-3}$  was not well executed; the subsequent conversion to  $\text{g dm}^{-3}$  was frequently calculated correctly.

The 3 or 4 significant figures required by the answer were often not considered by the candidates with both drastic rounding to 2 significant figures and full calculator displays being given.

Candidates frequently gave an array of numbers often leading to an incorrect final answer with no sign of processes or workings. This made it difficult to award marks for the steps through the calculation.

In part (b), the balancing number of '2' for both  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  was often omitted and electrons were frequently left in the overall equation.

In part (c), the colour brown was well known but the fact that a precipitate was made was frequently omitted; the equation often only had one  $\text{OH}^-$ .

Part (d)(i), the most common answer was 0, as candidates gave the overall oxidation number of the compound rather than the charge on the ion.

In (d)(ii), the concept of changes in oxidation number and assigning oxidation and reduction from these changes was well understood but candidates found identifying the specific oxidation number changes difficult. Many gave changes for H and for K.

In (d)(iii), this calculation was executed better by a larger number of candidates than the earlier calculation. The most common error was to give a 4:1 ratio, rather than a 2:1 ratio, for  $\text{K}_2\text{O}:\text{CO}_2$ . Again significant figures were not considered by a significant number of candidates.

### **Question 4**

Candidates found this question accessible and a significant proportion scored more than six out of the twelve marks available.

Only an extremely small proportion of candidates included transition elements other than iron or copper.

The best answers tended to be short and concise giving only one example each for the bonding and structure of the complex ion and the ligand substitution.

Most candidates were awarded the mark for quality of Written Communication, for the correct use of three of the technical words listed in the mark scheme.

The three typical properties of the compounds or ions were well known and many candidates scored all three marks. Some candidates included irrelevant typical properties of metals, e.g. electrical conduction, melting point, etc., but some candidates only gave these properties.

Complex ions of iron were well known. A significant number of candidates omitted the charge for their complex ion, thus not giving an example of a complex ion. Most candidates stated that the

bonding in a complex ion is called dative covalent or coordinate but a significant number omitted to state that the ligand donated a lone pair of electrons. Many candidates could either draw the three-dimensional representation of, or name, their chosen complex, but a significant number could not state the correct bond angle.

Ligand substitution was well known. Whilst many candidates did not give a written definition of ligand substitution, most gave balanced equations that illustrated ligand substitution. Balanced equations could score  $\frac{3}{4}$  of the marks available for ligand substitution (the fourth mark being available for the colours), but some of these omitted to include the substituted ligand on the right-hand side of the equation. However, some candidates included non-existent complexes or had the wrong formula. A significant proportion of candidates did not include the charge on the complex ion. The reaction of  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  with  $\text{NH}_3$  or  $\text{Cl}^-$  and the reaction of  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  with  $\text{SCN}^-$  were the most common examples of ligand substitution shown. The most common misconceptions were the reaction of  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$  with  $\text{SCN}^-$ ;  $[\text{Cu}(\text{H}_2\text{O})_4(\text{NH}_3)_2]^{3+}$ ;  $[\text{Fe}(\text{NH}_3)_6]^{3+}$ ;  $[\text{Fe}(\text{NH}_3)_6]^{2+}$ . Most candidates could give the correct colours for at least two complex ions.

## 2815/02 Biochemistry

### General comments

There was an improved performance on this paper; candidates generally found it accessible, producing confident answers to the questions on proteins and nucleic acids. At the top end, many scores in the 40 to 45 range were seen, showing that candidates had learnt the content of the specification thoroughly and were able to apply their knowledge effectively. These candidates were also able to write clearly with accurate use of technical terms.

Conversely, there were still many candidates scoring below 20, whose work showed a lack of knowledge of parts of the specification; this was often coupled with an inability to express their knowledge clearly. Common mistakes at this level were to suggest that disulphide bridges involve bonds between sulphur molecules, bond breaking releases energy, ester groups contain only one oxygen, and the structure of ribose includes HO–C bonds. Similar confusion about terminology led a number of candidates to describe translation rather than transcription in Q3, despite being informed of the nature of transcription in the question. A small minority was clearly quite unprepared for the examination.

### Comments on individual questions

#### Question 1

This question was generally well answered and was a good source of marks for weaker candidates.

- (a) (i) Most candidates wrote hydrogen bonding and the majority correctly described the link between amide NH and CO, often with a diagram. A number used carboxyl and amine groups by mistake.  
(ii) Most could name two types of interaction, but only about half were able to explain these accurately in words or with a diagram. SH–HS bonds were common.
- (b) (i) Most scored the mark for  $\text{Fe}^{2+}$ , the usual mistake being to write  $\text{Fe}^{3+}$ .  
(ii) All except the weakest wrote acceptable responses. These varied from the simple 'bonds or carries oxygen' to the more sophisticated 'forms dative covalent bonds with oxygen molecules'.
- (c) (i) Most picked up the first mark for identifying the oxidation numbers of O in water and molecular oxygen as  $-2$  and  $0$  respectively. Relatively few could see that the oxygen in hydrogen peroxide had to be  $-1$ ; instead candidates suggested wrongly that hydrogen somehow underwent a redox reaction. The complete correct answer, which included correct assignment of the oxidation and reduction labels, was uncommon.  
(ii) This was well answered at all levels, the usual mistake being to show competitive inhibition for **B**, or to allow the curves to drop towards the left instead of remaining flat.  
(iii) Most candidates answered this well, scoring the marks from two of the three possibilities available. The best answers referred to binding at an allosteric site and described a way in which the copper ions would interact with R groups on the enzyme.
- (d) (i) Most candidates had learnt this well.  
(ii) This was almost invariably done correctly, sometimes with more interesting processes than washing clothes such as DNA testing, stone washing jeans and

extracting fruit juice. A few, perhaps ahead of their time, suggested the Haber process.

## **Question 2**

This question proved to be the hardest for all but the very best candidates.

- (a) (i) Most correctly ringed an ester group, whether carboxylate or phosphate. A revealing mistake was to ring only CO.
- (ii) A few candidates, perhaps remembering some biology, scored both marks from the possibilities on offer in the mark scheme. A lack of precision in other answers lost marks, as did a failure to understand the word 'function'; this led candidates into descriptions of polar heads and non-polar tails which were not required.
- (b) A minority of candidates suggested, correctly, that van der Waals' attraction would be reduced by shortening the hydrocarbon chains or making them unsaturated. Several mentioned the inclusion of cholesterol in the bilayer, which did not answer the question set. Weaker candidates frequently left this part blank.
- (c) Although this type of question has appeared regularly over the years, only a minority of candidates was able to frame their expectation in terms of the exothermic nature of forming the O–H and C=O bonds in water and carbon dioxide. Few mentioned bonds at all and some thought that breaking the bonds in C–H was exothermic.

## **Question 3**

This question was well answered, providing a good source of marks at all levels but particularly for the weaker candidates who had learnt the details of transcription.

- (a) (i) Any suggestion of 'on top of' or 'above' the ring, or equivalent, scored the mark. Most achieved this but a few mentioned configuration, without elaboration.
- (ii) The majority used acidic or enzyme hydrolysis, with plain water being the commonest mistake.
- (b) The ring form was usually drawn correctly except for a few who had CH<sub>2</sub> at C1 or even the six-membered glucose. The open-chain caused more problems at the lower end of the ability range, with many COOH groups, C=O groups and CH<sub>2</sub> groups. Trivalent carbon was seen as well as OH–C bonds.
- (c) (i) The great majority recognised the significance of water being lost/eliminated as the polymer was made.
- (ii) Perhaps half placed their asterisk on the C5 oxygen or on C5 itself; both were accepted. Common alternatives were a phosphate oxygen or a nitrogen on one of the rings.
- (d) (i) This was well answered. The usual mistake was to write information for only one polynucleotide, leaving the reader to infer the other.
- (ii) This extended answer was very well answered by many candidates including weaker ones who had learnt this part of the specification. Bond breaking, bond making, complementary base pairing and the involvement of enzymes were all well covered. A number of candidates included these ideas in a description of translation or replication instead of transcription, but they were able to gain most of the marks.

**Question 4**

- (a) A good number of candidates suggested amylopectin or glycogen correctly because of the  $1\alpha$  configuration, and the 1,4 and 1,6 glycosidic links visible on the structure. Starch and, to a lesser extent, amylose were the popular alternatives. This topic had clearly been well learnt.
- (b) Most knew that hydrogen bonding was the key to the solubility of glucose. Most knew the number of suitable sites available on glucose was important. Too many spoilt this part of their answer by including hydrogen bonds to C–H.

Better candidates realised that glycosidic links made many OH groups less available for hydrogen bonding. However few scored the last mark for suggesting that other OH groups were tied up already with hydrogen bonding within the polysaccharide structure.

## 2815/03 Environmental Chemistry

### General comments

There was an improved performance from the small entry, particularly at the top end where there were several scores in the 40s. The scripts of the best candidates were characterised by sound knowledge, clear expression and an ability to think. Weak candidates revealed fragmented knowledge with poor powers of expression. It was notable that at most levels the clay chemistry in the Specification had been learnt and mastered.

### Comments on individual questions

#### Question 1

- (a) (i) Most suggested that the cover would encourage anaerobic respiration, but many were then struggling. Some suggested that it would prevent leaching but omitted to mention that rainwater that would trigger the process. Many used their answers to (ii) which were not accepted unless they happened to mention smell.
- (ii) The majority scored all four marks. The commonest errors were to suggest unlikely gases such as NO or CO, or to write that hydrogen sulphide was harmful rather than toxic.
- (b) (i) Most suggested acid rain and the poisonous nature of the gas. Some lost the second mark by stating the gas to be harmful or to destroy the ozone layer – at the wrong level in the atmosphere.
- (ii) This proved to be the more difficult of the two equations, with some candidates finding the balancing beyond them.
- (iii) This equation had a variety of possible answers depending on the proportions of nitrogen monoxide and ammonia used, and was better answered. Many scripts were covered in trials, which usually ended up with a correct answer.

#### Question 2

- (a) (i) Many candidates appreciated that a shift of the equilibrium, not the equation, to the right was necessary. Perhaps half of those suggested the trigger – the loss of water and carbon dioxide by evaporation.
- (ii) About half the candidates obtained the correct answer of 961,000 g, but few laid out their working clearly: expressions such as:  
 $100000 \times 0.096 = 9600 \times 100.1 = 961000$ , are mathematically unsound. Weaker candidates managed only the  $M_r$  and several then went on to use the calcium hydrogencarbonate figure by mistake. Another common error in the method was to introduce an unwanted 1000 at the first step:  $100000 \times 0.096/1000$ .
- (b) This proved entirely straightforward for those who had learnt this part of the specification. The weakest candidates wrote too vaguely to score any marks. Aluminium ions were needed either to neutralise the negative charge on the surface of colloidal particles or to form a gelatinous precipitate of the hydroxide which would entrain colloidal particles as it settles. Chlorine, chloric acid or chlorate ions needed to be used as an oxidising agent to destroy bacteria. Simply killing the bacteria was insufficient.

### **Question 3**

- (a) (i) There were many good answers. A common mistake with the oxygen only model, was to forget the need to generate oxygen atoms by photolysis of oxygen molecules. Several candidates added inappropriate equations, sometimes using CFCs to generate chlorine radicals. This was not asked for.
- (ii) Perhaps a third drew an acceptable diagram, most of those suggesting a single bonded triangular arrangement of the oxygen atoms. Only the best candidates used a double bond coupled with a dative bond.
- (b) (i) Nearly all mentioned skin cancer, but only a third emphasised that the damage would allow more UV to reach the Earth's surface to cause this.
- (ii) All except the weakest candidates were able to make one or two sensible suggestions, the most common being that the alternatives should break down in the troposphere and should not have too high a greenhouse factor.
- (c) (i) Even the better candidates had difficulty in breaking a bond rather than a molecule although most ended up with two free radicals.
- (ii) This was well answered by most candidates. The best included ozonides and carbonyl compounds in their explanations.
- (iii) The great majority had heard of catalytic convertors, and many could write a correct equation. The only problem for some lay in the balancing.

### **Question 4**

This question about clays was very well answered by the upper half of the candidature, many of whom scored 8 to 10 marks. Even marginal candidates managed 5/6. Candidates revealed a sounder knowledge of this part of the Specification than has usually been the case in the past, and were familiar with many of the technical terms required.

Many knew details about the hydrogen bonding between layers in 1:1 clays but few gave details of the bonding which holds each layer together. Weaker candidates sometimes muddled the two types of structure, suggesting that it was the layers in 2:1 clays that were hydrogen bonded. There was the usual confusion in places between ion substitution in the clay structure, and the resulting ion exchange that was then possible on its surface.



## 2815/04 Methods of Analysis and Detection

### General comments

Examiners were greatly encouraged to see many scripts which demonstrated a high level of understanding of this area of Chemistry. Many candidates gave extremely good answers. There was no evidence that candidates had too little time to complete the examination, nor that they were unprepared for this examination. Questions requiring candidates to use more than one area of the specification to determine the structure of compounds were approached very well and in a logical way by most candidates. It is very pleasing to see that advice from previous Principal Examiner reports about how to express some of the scientific principles within this specification have been adopted by both teachers and candidates.

### Comments on individual questions

#### Question 1

- (a) (i) The majority of candidates were able to identify an inert gas as the mobile phase and the liquid as the stationary phase. Those that did not gain these marks either reversed the two phases or were confused with paper chromatography.
- (a) (ii) Many candidates correctly described retention time as the time taken from injection of the sample to its emergence. Those that did not gain this mark often were unable to be precise enough and gave vague answers such as 'the time taken to come out'.
- (b) Quite a large number of candidates did not interpret the trace correctly. They suggested that peak 1 (that had the shortest time from injection) had been caused by 2-methylhexane (the largest molecule), rather than pentane (the smallest molecule). If candidates correctly identified pentane for peak 1 they usually were able to correctly identify hexane as being responsible for peak 2.
- (c) (i) All but the weakest candidates were able to describe a chromophore as being part of a molecule that absorbs UV/visible light.
- (c) (ii) This question was answered significantly better than similar questions in recent years. The first mark was for identifying that curcumin has more conjugation (or has more areas of delocalised electrons). It was necessary for candidates to use some comparative language rather than just to state that there is delocalisation of electrons. The second mark was for linking the extended delocalisation to the reduction in the energy gap between energy levels. The third mark was for stating that electrons now absorb light energy of longer wavelength within the visible part of the spectrum. This mark was awarded much more often than in previous papers, many candidates being able to use correct terminology and express this absorption (rather than a phrase such as 'so it is in the visible' without any absorption being mentioned).

#### Question 2

- (a) A pleasing number of candidates were able to accurately describe how the lines of emission spectra arise. They gained marks for stating that energy levels are quantised and that electrons release energy when they drop down from one level to another.
- (b) (i) A very large number of candidates were able to explain that convergence happens because energy levels get closer together towards the edge of an atom.

- (ii) A significant number of candidates were able to draw vertical lines getting closer together for one mark but very few candidates showed this happening from right to left on the question paper towards shorter wavelengths; the majority showed convergence incorrectly towards larger wavelength.
- (c) Almost all candidates were familiar with this type of calculation and were able to work through in a logical way using correct formulae. Weaker candidates found the conversion of kJ to J and from m to nm taxing. Many divided the energy by 1000, rather than multiplied it by 1000, and converted m to nm by multiplying by  $1 \times 10^{-9}$  rather than by  $1 \times 10^9$ . A correct answer of 588 or 589 nm gained 4 marks. A common error was to ignore the instruction to give the answer to three significant figures.
- (d) Answers to this question were disappointing. Many candidates firstly seemed unable to know what to write about, thinking the question was asking for the principles of flame emission spectroscopy rather than a description of a practical procedure. Candidates should be reminded that the question 'describe how' is often asking about a practical chemical method whereas the question 'explain why' is asking for a theoretical description of chemical principles. Those candidates who did describe a practical method often did so clearly. Correct answers described the setting up of a calibration graph, measuring the intensity (rather than a phrase such as 'get the results') of the particular blood sample in question, and determining the concentration from the calibration graph.

### Question 3

This question was very well answered by many candidates, even those who struggled with the other three questions.

- (a)
  - (i) Almost all candidates were able to identify carbon-13 as being responsible for the M+1 peak.
  - (ii) Candidates using the correct formula easily calculated that 10 carbons would be present. Examiners saw some interesting attempts to make up for incorrect calculations such as 10.99 being rounded to 10. It is recommended that candidates show their working in such calculations, even if the question does not ask for it.
  - (iii) The candidates were asked to show working in this question and were not awarded full marks even for a correct formula of  $C_{10}H_{14}$ . The minimum required for working was an indication of  $M_r$  of 134, and a deduction of the mass contributed by the number of carbons shown in (ii) (usually  $10 \times 12 = 120$ ).
  - (iv) Examiners were looking for a precise fragment ion for the X peak at 77 and  $C_6H_5^+$  was the correct answer. Omission of the charge did not gain this mark.
- (b)
  - (i) Many candidates were able to suggest that the singlet was an indication that any adjacent carbon atoms had no hydrogen atoms attached. Confusion arose for some candidates over which proton environment they were describing and this gave rise to incorrect answers such as 'no adjacent hydrogen atoms'.
  - (ii) This mark was possibly the most commonly awarded on the whole paper, the correct answer being a hydrogen atom attached to a benzene ring.
- (c) Many candidates gained 1 mark for showing a structure that contained a benzene ring, but the second mark for the rest of the structure,  $-C(CH_3)_3$  attached to the benzene ring, was not awarded very often.

### Question 4

- (a) In parts (i) and (ii) candidates were required to show at least one of their chosen fragment ions with a positive charge.
  - (i) There were a number of possible ions that would show a peak in all three of **B**, **C** and **D**. The most common correct response was  $CH_3^+$  or the molecular ion.

- (ii) There were a number of possible correct answers, the two most common seen being  $\text{CH}_3\text{CH}_2^+$  or  $\text{CH}_3\text{CH}_2\text{CH}_2^+$ .
- (b) From this infra-red spectrum, the key to correctly identifying isomer **B** was the identification of the O–H bond from the *Data Sheet*. The trough that distinguished the isomers occurs at  $3230\text{--}3550\text{ cm}^{-1}$ . Incorrect responses arose from candidates assuming the O–H trough was at  $2500\text{--}3500\text{ cm}^{-1}$ , leading to isomer **C** being identified. Those candidates who had experience of dealing with many infra-red spectra were able to see the subtlety of this trace and so to correctly interpret it. Candidates should be encouraged to see as many traces as possible during their study of this module and also to take time and care when interpreting them in an examination situation.
- (c) The vast majority of candidates correctly labelled the peaks on the n.m.r. spectrum as belonging to, from left to right, hydrogens c, b, d.
- (d) This question required candidates to look at molecules and to predict the n.m.r. spectra that would be produced by them. They were also required to compare the spectra and this was consequently quite a difficult skill. The best answers were often those that set about the answer in a logical way, for example by drawing a table and listing the hydrogen environments, chemical shift values, splitting patterns and relative peak areas.

## 2815/06 Transition Elements

### General comments

This paper was completed to a very high standard by a large number of candidates. Clearly candidates have been well prepared for this part of the specification and they have benefitted from the back catalogue of past papers, mark schemes and examiner's reports which are available to them.

Good candidates were given ample opportunity to demonstrate their knowledge and understanding; it was pleasing to see the depth of understanding shown in some of the more difficult concepts. Calculations were well answered but even able candidates found it difficult to cope with a dilution factor. Chemical equations can still cause problems, even at this late stage of an 'A' Level course.

### Comments on individual questions

#### Question 1

Candidates generally knew the formulae, colours and oxidation states of the main ions of vanadium. A common mistake was to suggest that the oxidation state of  $\text{VO}^{2+}$  was +2.

In (b)(i) a correct balanced equation was seen rarely.

In (c), a common mistake was to state that the catalyst was  $\text{V}^{5+}$  or vanadium oxide, without giving the oxidation state, and many candidates gave the reaction between  $\text{SO}_3$  and water as the example of the catalysed process.

#### Question 2

Water was often suggested to shift  $\text{CrO}_4^{2-}$  back to  $\text{Cr}_2\text{O}_7^{2-}$  rather than  $\text{H}^+$  and many candidates showed no change in the oxidation number of chromium in (a)(iii) when the requirement was to show no change in the oxidation state of chromium, oxygen and hydrogen.

In part (b) there were many correct answers but a common mistake was to forget to multiply the moles of  $\text{Fe}^{2+}$  by 10 to convert from  $25 \text{ cm}^3$  to  $250 \text{ cm}^3$ . Consequential marking was applied, often resulting in 4/5 marks being awarded.

#### Question 3

Part (a) was generally well answered but candidates lost marks in (b) by not labelling the platinum electrode or by suggesting that the electrode was made of solid chlorine. Some candidates did not use a salt bridge or the bridge was not in contact with the solution in the beaker.

In (c)(ii) candidates suggested that you would see a brown precipitate whilst others suggested that bromine gas would be evolved.

In (d) some candidates failed to score the mark because they explained why  $\text{Cr}_2\text{O}_7^{2-}$  would not oxidise  $\text{Cl}^-$  to  $\text{Cl}_2$  but did **not** explain why it would oxidise  $\text{Br}^-$  to  $\text{Br}_2$ .

#### Question 4

In (a)(ii), colourless was not credited for the colour of  $\text{TiO}_2$ . Most recognised the co-ordinate bonding in Manganese Blue.

(b)(ii) was able to differentiate very good candidates who showed a clear understanding of the requirements for a compound to be coloured.

The visible spectrum in (c) was arguably the most difficult mark on the paper with candidates drawing a range of graphs with absorbances in the violet and blue regions as well as maxima well before the red region of the visible spectrum.

#### Question 5

Candidates have been well drilled about stereoisomerism in transition metal complexes and relatively few candidates drew complexes that were not three-dimensional. There is some confusion about which isomer is *cis* and which is *trans*.

Optical isomerism is slightly less well known and when describing the non-superimposable nature of these, the word mirror was often omitted.

Cis platin was well known as a transition metal complex used to treat cancer. Candidates failed to score if they claimed that the complex is bound to 'cells' rather than to DNA. A few candidates described organic compounds used in medicine, such as thalidomide or paracetamol, rather than the transition metal complex asked for in the question.

Generally speaking, candidates performed very well on this question and even relatively weak candidates managed to collect marks.

## 2816/01 Unifying Concepts in Chemistry

### General comments

Overall the performance of candidates on this paper was impressive compared with previous years. It was clear that for many there were major topics such as reaction rates or the theory of weak acids and buffers which were well understood and where candidates scored highly. The ability to carry out chemical calculations was also well displayed with many candidates making light work of the extended calculation in parts 3(c) or 5(c) for example. Where candidates did struggle was with some of the more fundamental chemistry. This certainly showed in 4(b) when candidates were not able to write an equation for the reaction of magnesium with acid or to employ oxidation states successfully to identify what had been reduced. The ability to write a balanced chemical equation is a skill which is fundamental to chemical literacy. It is important that the teaching of the A-level course does not produce candidates who can describe the action of a buffer in great detail but cannot provide the formula of a simple salt. This said, however, the ability of candidates to answer the sort of questions asked in this paper has improved tremendously over the lifetime of this paper and augurs extremely well for the future.

### Comments on individual questions

- 1) (a) (i) The majority of candidates got off to a good start obtaining this first mark. The number who chose to answer in terms of mole fraction were in the minority with most preferring to talk about the pressure that a gas would exert if it occupied the container alone. In some cases these answers sailed rather close to the wind and some candidates certainly could have learnt this definition a little more carefully.
  - (ii) This was very well answered with the vast majority of candidates giving the correct answer.
  - (iii) Again in the main it was very pleasing to see the great majority of candidates gave a correct expression in answer to this question. The most common error was to use square brackets confusing their answer with the expression for  $K_c$ , a mistake that appeared to be very centre specific. Another error involved leaving out any symbol for pressure, perhaps a sign that some candidates were rushing a little through these initial questions.
  - (iv) The opening part of this calculation was very well handled and even those candidates who had made errors in the earlier parts were able to use their expression from part (iii) and their value for the partial pressure of oxygen to calculate  $K_p$ . In the main the units were also given correctly. It was noticeable that a significant number of candidates converted all the values into Pascals in order to calculate  $K_p$  and its units. While there was nothing wrong in so doing it did give an additional opportunity to make a slip and was unnecessary. The least well-answered part of the question by a considerable margin was to give the answer to the correct number of significant figures. The majority of candidates had clearly been drilled in the use of three significant figures and had not been taught to examine the number of significant figures in the given data. In the main, only the top candidates expressed their numerical answer to two significant figures and picked up this mark.
- (b) This was very well answered with the majority of candidates picking up both marks. Some took quite a long passage to convey what they wanted to state but the content was more often than not completely sound.

- (c) The first part of the question was very well answered and nearly every candidate discussed the relative number of moles of reactant and product gases. All who attempted the second part also gained the mark but it was noticeable how a number of good candidates, having discussed the affect of pressure on the position of equilibrium, then forgot to answer this part of the question.
- (d) (i) Of the two components of this calculation that which involved the division of the molar mass of sulphur by the relative formula mass of  $\text{H}_2\text{SO}_4$  was nearly always correctly calculated. Candidates often introduced errors during the conversion of tonnes into grams. It is a pity that more candidates do not approach these questions as an exercise in simple ratios and so do not need to change units, rather than working out the number of moles of reactants and products which then does necessitate the change of mass into grams.
- (ii) This was very well answered with all but the weakest candidate giving a correct equation.
- 2) (a) (i) With fewer sets of data to compare than has been the case with this question in previous years, candidates found this opening part to the second question very straightforward and it was extremely pleasing to see the vast majority pick up all four of the available marks.
- (ii) Again this was very well answered and even those who had slipped up on the answer to (i) were able to give a rate equation that matched their findings.  
Where errors were made they tended to involve writing  $k = [\text{OH}^-] [\text{ClO}_2]^2$  or leaving out 'rate =' from the correct expression. These errors were, however, relatively infrequent.
- (iii) The majority of candidates were able to substitute the values from the table into a rearranged expression and so generate a correct value for  $k$ . What proved slightly more challenging was working out the correct units but even here there were many candidates who moved straight to the correct answer without any evidence of working out.
- (b) (i) This was a demanding question that was beyond many candidates. Some candidates got somewhat to the answer but were often simply recalling facts about the rate equation rather than applying that knowledge to this specific example. Only the very able candidates were able to pick up the mark.
- (ii) Again, candidates found this very difficult. Some did not seem to pick up on the information available in the stem of the question which gave both the number of moles of each reactant along with the formula of the chlorate(III) ions and the fact that chlorate(V) ions were also formed. As a result many suggested answers that did not contain the information given in the question.
- 3) (a) Although this was correctly answered by the majority of candidates it was noticeable how many candidates, having given the correct formula of the products, failed to use an equilibrium symbol using instead a simple arrow and so did not gain the mark.

- (b) This was well answered. Occasionally candidates who had given the form of the equilibrium in part (a) involving  $\text{H}_2\text{O}$  went on to use the concentration of water in their expression for  $K_a$  and so did not gain this mark.
- (c) In the main, the answers to this problem were extremely well handled. Many candidates had clearly mastered these calculations and picked up all five marks. Interestingly of the two parts to the calculation, these being the calculation of the molar concentration and the evaluation of pH, it was the first that some candidates missed out on using the given value of  $3.4 \text{ g dm}^{-3}$  as the molar concentration. A few candidates did not gain the final mark by quoting their pH value to only one decimal place.
- (d) It was very clear from this answer, as indeed was evident in last summer's paper, that many candidates are now well prepared for a question that asks for a discussion of a buffer solution. Such candidates quickly obtained all five marks available for the discussion part of this section although it was noticeable how a large number of these candidates did not use a discussion of the acid equilibrium in their answer and so did not achieve the mark for quality of written communication. Less well-prepared candidates still struggled with the discussion. Among such candidates, some represented the dissociation of the salt as an equilibrium while others recognised that the conjugate base would react with added protons from the acid but then reasoned that the decrease in proton concentration would lead to further dissociation of the acid and so suggested the wrong shift in the position of the acid equilibrium.

The calculation proved more challenging than that asked for in part (c). A large number of candidates used the Henderson-Hasselbalch equation to attempt the calculation of pH but as is common when candidates rely on this equation, they did not recall it correctly, often swapping over the concentrations of the acid with the salt or changing the sign of the  $\log\{[\text{A}^-]/[\text{HA}] \}$  term. Much more successful were those candidates who simply used the expression for  $K_a$  to work out the proton concentration and hence the pH. A number of weaker candidates attempted to work out the pH using the method in part (c).

- 4)
  - (i) Despite excellent answers to the questions involving calculation of pH in the preceding question, many candidates struggled to convert a pH of 1 into a concentration of nitric acid.
  - (ii) This was well answered with many candidates noting both the value of the final pH and the pH range of the vertical section of the pH curve.
  - (iii) Surprisingly and somewhat depressingly this proved to be one of the most challenging questions on the paper and very few candidates were able to give the correct formula for ammonium nitrate. One of the common errors was to combine the two formulae they had been given in the question and then remove water to give  $\text{N}_2\text{H}_2\text{O}_2$ . A large number of candidates were simply unable to come up with anything that even approached the correct answer.
  - (iv) Following part (iii), many candidates breathe a sigh of relief at the sight of this question and all but a handful of candidates gave a correct answer.
  - (v) Candidates struggled with this part more than might have been expected. Some recognised that the rapid change in pH would come when less ammonia solution had been added but did not go further to state the volume of aqueous ammonia required. Many concentrated on what would happen to vertical section of the pH curve and so did not pick up any marks. Some candidates recognised that the final pH would be higher but then suggested



unrealistic values for the pH of the weak base, such as 14, and so did not score the mark.

- (b) (i) Although there were candidates who gained both marks for this part, there were many with very poor answers. Some attempted equations in which the formula of the magnesium nitrate was given as  $\text{MgNO}_3$  while others who had given a correct equation were then all at sea when it came to giving the ionic equation.
- (ii) Given that answers to this sort of question are often well handled in the AS paper it was disappointing to see so many candidates wrong-footed here. In particular it was noticeable how some candidates suggested that magnesium had been reduced in the reaction with dilute nitric acid. The second reaction proved somewhat easier as the formula of both  $\text{HNO}_3$  and  $\text{NO}_2$  were given in the question and many more candidates gained this second mark.
- 5 (a) This calculation wrong-footed a significant number of candidates. Some used the formula mass of  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  in the opening calculation and so dropped this first mark. Many, having worked out the number of moles of Plaster of Paris, then multiplied this by 18, forgetting that it takes an additional 1.5 moles of water for the Plaster of Paris to set. A significant number of candidates who did obtain the correct answer, worked out the mass of water needed by subtracting 500 g from the mass of the set Plaster of Paris which they had calculated.
- (b) Here again although many candidates gained both marks some were confused by this calculation. Even when the method was sound, some candidates went awry by using 14 as the relative molecular mass of nitrogen. Others obtained a rounded number of moles of nitrogen as 0.02 and so obtained a value of 76 for the relative molecular mass of the unknown gas which was then too distant from 71 for them to suggest chlorine. A small but significant number of candidates did manage to obtain a value of 71 but then could not suggest a suitable gas.
- (c) (i) This was well answered and only a few candidates did not manage to count up the number of each atom correctly.
- (ii) It was very pleasing to see how many candidates were able to work through this calculation without any errors. Where there were mistakes, the two more common involved either the stoichiometric ratio of the reactants or a failure to scale by a factor of ten. In the first case, candidates often obtained the number of moles of citric acid by multiply by three the number of moles of sodium hydroxide, while in the second case candidates forgot to scale by ten the value they had obtained for  $25 \text{ cm}^3$  to work out the mass of the acid in  $250 \text{ cm}^3$ .

## 2816/02 A2 Coursework

### General comments

The vast majority of centres submitting candidates' coursework have been doing so for a number of years and, in the majority of cases, they have become sufficiently familiar with the standards expected to ensure that the work has been correctly assessed. This is, of course, a great help to the Moderators who were grateful for the orderly presentation and accurate marking that was generally the norm. Nevertheless a feature of this year's moderation was the presence of an unusually large number of clerical errors in the marks submitted. Centres are urged to double-check the MS1 forms before dispatching them to OCR. However, usually the necessary documentation was correctly provided and there were many fewer instances where 'Centre Authentication' forms were found to be missing. It might be worth a reminder though that these are not required for individual candidates.

Nearly all centres used the exemplar experiments provided and, although alternatives are perfectly acceptable, they must be of an equivalent standard.

### Comments on A2 Coursework

As in previous years, the most popular Planning exercise was the identification of an organic unknown. The Plans submitted were often spoiled by the failure of candidates to appreciate that phenol will decolourise bromine and phosphorus pentachloride and sodium will react with carboxylic acids as well as alcohols. A number tested for a primary alcohol by oxidation with potassium dichromate before ruling out the aldehyde. These errors were not always detected by centres. P7b, which requires full details of the tests being used, was sometimes awarded generously as suitable quantities were not specified. Plans for the determination of a rate equation usually scored five marks but, to achieve P7b, some comment on the use of  $1/\text{time}$  to represent the rate for this experiment is expected as is a reference to the teacher's demonstration.

The implementation skill was usually well done. A leeway of  $\pm 4^\circ\text{C}$  is allowed for the measurement of the melting point of a solid. If this is not achieved, I7a should not be awarded. Occasionally centres were inclined to be rather more generous when allocating marks.

Over the years in which the practical assessment has been available, there has been a marked improvement in the ability of candidates to perform calculations and it was apparent on this occasion. The Moderators were less happy with the quality of the graphs that were drawn based on the results of the rate experiment and many candidates were very keen to force a straight line through points which did not show any particular trend. The misunderstanding that half-lives or gradients taken from concentration (or volume)  $\sim$  time graphs can be used to interpret 'initial rate' data was once again noticed. This mistake inevitably led to a loss in marks.

The evaluation skill is always the hardest for candidates and, although many were able to identify potential procedural and measurement errors, they frequently failed to specify which of these were significant. Improvements to experiments were also sometimes too vague or impractical to be accepted. There was a tendency to suggest apparatus that could be 'automated' or 'attached to a computer' without giving any indication as to how this could be realistically accomplished.

## 2816/03 Unifying Concepts in Chemistry (Practical Examination)

### General comments

The Examination gave candidates a good opportunity to display the skills being tested. Marks for the Plan were somewhat lower than usual – many candidates remain unable to describe redox titrations to the level of detail needed.

### Comments on individual questions

**Plan** The Plan was well answered by many candidates, although even some able candidates tended to be somewhat careless in terms of the depth of detail given. Candidates were expected to describe a quantitative dilution of the hydrogen peroxide prior to titration and to justify the dilution factor that they had suggested. The latter part of this discriminated very well. The directions for the Plan asked candidates to give relevant 'chemical understanding' of their procedure, but many did not discuss or explain the redox nature of the titration they were carrying out. Some candidates were confused as to why the titration mixture goes pink at the end of this titration. Others wasted time by showing a calculation of the concentration of  $\text{H}_2\text{O}_2$  from their titration data, although the instructions given on the question paper clearly excluded the need to do this.

Virtually all candidates used a gas collection method as their second technique. However, credit was given to the few who chose alternative valid methods such as mass loss (due to oxygen liberated) or measurement of enthalpy change of catalytic decomposition. Candidates were expected to explain what '100 volume'  $\text{H}_2\text{O}_2$  means and to carry out a calculation to show that its concentration is about  $8.3 \text{ mol dm}^{-3}$ . A disappointing number of candidates used a measuring cylinder to measure their diluted peroxide, rather than a more accurate piece of apparatus. Examiners were looking for an observable detail (such as 'stops fizzing') as a cue to measure the final volume of the gas produced.

**Test** **Part 1** The standard of accuracy of most candidates from most centres in the titration was very high, but centres are reminded that it is essential that the Supervisor's results submitted should be both accurate and reliable.

**B** **Part 2** The first section of the calculation on Page 4 was generally answered well by all but weaker candidates. It was disappointing that, in (a), even at A2 level, a few candidates do not know how to convert a mass into the number of moles. Part (e) proved very difficult: only the most able candidates realised that the answer to (d) needed to be multiplied by both 10 and 100 to reach the final answer.

- Part 3** Almost all candidates carried out this exercise to a commendably high level of accuracy. A few were let down by inconsistency in their use of decimal places when measuring the temperature.
- Part 4** Few candidates were able to complete the whole calculation correctly, although most were able to carry out at least a couple of the steps. There were very few negative signs given in the answer for the enthalpy change.
- Part 5** Sections (a) and (b) of the Evaluation were generally answered well by most candidates. In (a)(iii) some candidates referred to accuracy features (such as accurate calibration of the burette) rather than focus on the consistency of their data to explain why their results were reliable.

Answers to (c) were often disappointing. Despite having written Plans involving hydrogen peroxide, some candidates thought that the '100 volume' solution was the more dilute. Others did not read the question and discussed the titration, rather than the enthalpy experiment. However, many candidates produced some good answers in terms of more frothing during reaction, greater loss of heat and a greater % accuracy of the temperature measurement. Only a few candidates were alert enough to comment that ten times the amount of heat would be produced from the '100 volume' solution, leading (potentially) to an extremely high temperature being produced that would cause a significant evaporation of the solution.

# Grade Thresholds

Advanced GCE Chemistry (3882/7882)  
June 2009 Examination Series

## Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	49	44	39	34	29	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	44	38	32	27	22	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	97	87	77	67	57	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	97	87	77	67	57	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	91	80	70	60	50	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	70	61	52	44	36	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	73	65	58	51	44	0
	UMS	90	72	63	54	45	36	0
2815B	Raw	90	72	65	58	51	44	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	73	66	59	52	46	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	75	68	61	54	48	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	97	87	77	67	57	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	97	87	77	67	57	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	91	80	69	59	49	0
	UMS	120	96	84	72	60	48	0

## Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3882	300	240	210	180	150	120	0
7882	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>U</b>	<b>Total Number of Candidates</b>
<b>3882</b>	32.9	57.4	75.3	88.9	97.9	100	2936
<b>7882</b>	31.7	56.6	74.8	87.6	96.3	100	11875

**14811 candidates aggregated this series**

For a description of how UMS marks are calculated see:

[http://www.ocr.org.uk/learners/ums\\_results.html](http://www.ocr.org.uk/learners/ums_results.html)

Statistics are correct at the time of publication.

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