

# **Chemistry**

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

## **Report on the Units**

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**January 2010**

**3882/7882/MS/R/10J**

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

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# Chief Examiner's Report

## General comments

This January's series sees the transition from the A2 units in the old 'legacy' specifications to the new revised specifications. With new A2 candidates now entering for the new F324 unit, *Rings, Polymers and Analysis*, the entry for the legacy units was drawn almost entirely from re-sit candidates in their third year of A level study.

Entries for all units were small with few candidates.

The quality of the work seen was polarised, largely comprising a mixture of excellent and poor scripts. Some candidates had prepared extremely well for the units and were obviously intent on pushing up their A-level grade. At the other extreme, responses seen on some scripts suggested that little if any chemistry had been studied since the June 2009 series.

In June 2010, the legacy A2 papers will be offered for the last time and the series will offer the last opportunity for 7882 aggregation. The transition to the new specifications will then be complete.

## 2814 Chains, Rings and Spectroscopy

### General comments

This paper was taken by a relatively small number of candidates, most of whom were re-sitting the unit. Therefore the range of marks did not correspond to the usual level of performance seen in this series. However, there were still a good number of candidates who had prepared well. These candidates demonstrated a good knowledge and understanding of the ideas covered in the specification. There were few very poor scripts, although some did appear to attempt the paper with minimal revision. Nearly all candidates seemed to finish the paper in the time allowed.

### Comments on individual questions

1

- (a) Few candidates had problems showing the structure of 4-methylphenylamine. Although the question asked for a displayed formula, any structure which unambiguously showed the correct structure and connectivity of atoms was credited.
- (b) This extended question about the nitration of methylbenzene and reduction of the nitro-group was very well-answered by those candidates who had revised thoroughly. As methylbenzene is more reactive than benzene to electrophilic substitution, any temperature above room temperature and below 60 °C was credited as a suitable condition for this reaction. Quality of Written Communication was available for those who had organised their answer well and clearly identified the type of reaction occurring in each part.
- (c) Candidates needed to show the structure of the diazonium ion, including the correct position of the positive charge. Weaker candidates found this part more difficult, with some also making errors in interpreting the skeletal formula of the azo dye to deduce the number of carbon and hydrogen atoms.

2

- (a) The general formula of an amino acid was well known.
- (b) Many candidates scored well on this part, and it was pleasing to see how many could draw the two 3-D mirror image structures correctly. This is a skill that has improved significantly over the lifetime of this unit and teachers are commended for their good work in this respect.
- (c) The ionisation of amino acids at different pHs was well understood by many, although some did lose marks by not reading the questions carefully enough and drawing the wrong amino acid for one or other part.
- (d) There were three possible dipeptides and candidates were credited for correct structures of any two. Some weaker candidates lost marks by attempting to draw a section of a polymer rather than a dipeptide.
- (e) A suitable catalyst for the esterification reaction should not contain water, so any non-aqueous strong acid was credited for this part.
- (f) This last part was a little more challenging, but it was pleasing to see a good number of candidates identify the correct product with two ester linkages.

3

- (a) The whole ester group had to be circled for the marks here.
- (b) Any correct name of the dicarboxylic acid was credited. Many candidates deduced the correct structures of the other two monomers.

- (c) The displayed and skeletal formulae of the hexanedial were well done and it has also been pleasing to see candidates steadily increase in confidence with drawing skeletal formulae over the lifetime of this unit. Any equation showing the correct formulae of the aldehyde and the carboxylic acid balanced with 2[O] was credited for the oxidation reaction.
- (d) The structure of the polymer was deduced correctly by many, although some weaker candidates did not recognise the need for an ethyl side chain.
- (e) Almost every candidate answered this part correctly.
- (f) A fair number of candidates knew that atactic polymers had their side chains arranged randomly somehow but, to gain credit, it had to be clear that this referred to the orientation of the side chains (and not their position along the chain). The same applied to describing an isotactic polymer. Although space was not given for a diagram, credit was given if a drawing clarified a candidate's attempted explanation in words.

4

- (a) The calculation was relatively straightforward for A2 candidates, although the weaker candidates often forgot to take account of the mole ratio of carbon dioxide and water. Some also did not spot that an answer in  $\text{cm}^3$  rather than  $\text{dm}^3$  was required.
- (b) This part was probably the most difficult on the paper, with many candidates only scoring two or three marks out of a possible six. Most recognised that the chemical shift of the carboxylic acid protons would cause the peak at  $\delta = 11.2$  ppm and that this peak would disappear in the presence of  $\text{D}_2\text{O}$ . However, relatively few explained *why* the peak disappears in  $\text{D}_2\text{O}$  or how the other two peaks could be used to explain why structure **E** was responsible for the given n.m.r. spectrum. Many candidates ran into problems by trying to use the typical chemical shifts in the *Data Sheet* to identify peaks **Y** and **Z**. Only the most able candidates spotted the need to use the relative peak areas and/or number of proton environments to solve the problem.

5

- (a) This part was well done, although a few candidates only gave the structure of the functional group and this could not be credited as the question asked for a name.
- (b) The definition of stereoisomerism is still not well known, with a common error being to describe the isomers as only having the same molecular formula. It must be clear in some form of words that stereoisomers also have the same *structural* formula. Many candidates recognised that the restricted rotation of the  $\text{C}=\text{C}$  bond caused the stereoisomerism in the given compound, although for full credit they needed to point out that two distinguishable groups are also required on each carbon atom to create stereoisomers.
- (c) The combustion equation was well-answered.
- (d) The use of  $\text{NaBH}_4$  (or  $\text{LiAlH}_4$  in ether) for the reduction of the aldehyde was known by many candidates, although some forgot that this reaction adds two H atoms when writing the equation.
- (e) The nucleophilic addition mechanism was described in full by well-prepared candidates. To gain full credit, the carbonyl carbon had to be attacked by a lone pair from the carbon on a nitrile ion. Some weaker candidates seemed to know the mechanism, but found it more difficult to apply it in the context of this larger compound shown with a skeletal formula. The hydrolysis of the nitrile to a carboxylic acid, by heating with a suitable aqueous strong acid under reflux, was only well-described by the best candidates.

- 6** This question gave candidates the opportunity to interpret a larger amount of given information to identify the three different compounds and to explain their reasoning. The best candidates scored full marks, although most were able to identify at least one of the compounds. Some did not show how the mass spectrum can be used to obtain the  $M_r$  of 72, although they had clearly obtained this value somehow. The most common error was to assume that one proton environment would mean that compound **B** was pentane, rather than 2,2-dimethylpropane.
- 7** This extended writing question was very well-answered by those candidates who had prepared thoroughly. A good number showed evidence of having practised similar questions in the past and produced almost faultless answers. Common errors by less confident candidates were in the equations or in the explanation of the effect of the differing electron densities around the benzene ring on the bromine electrophile. Quality of Written Communication was awarded for good spelling, punctuation and grammar in the context of sentences or note form. This mark was obtained by most candidates.

## 2815/01 Trends and Patterns

### General comments

The whole mark range was covered from 1 to 45. There was no evidence that candidates ran out of time and many candidates wrote at length in the final question.

As in previous series, many candidates did not use chemical terminology with precision although there was a little improvement compared to previous examination papers over the use of the terms *atoms*, *ions*, *molecules* and *intermolecular forces*.

Calculations were attempted in a much more structured way than seen in previous examination papers although significant figures were not considered by quite a large number.

Candidates showed good understanding of the Born–Haber cycle although there was some confusion between lattice enthalpy and enthalpy change of formation.

Candidates found difficulty with experimental observations.

Candidates found deducing oxidation numbers difficult.

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

### Comments on individual questions

#### Question

- 1
  - (a) The majority of candidates answered this correctly. However, a small but significant number of candidates confused lattice enthalpy with enthalpy change of formation.
  - (b) Many candidates performed the calculation correctly although there were a significant number who confused the signs.
  - (c) The relative sizes of the sodium and caesium ions and their relationship to the strength of the electrostatic forces was well known but the majority of candidates answered in terms of the lattice energy being smaller or larger rather than in terms of being more exothermic or larger in magnitude.
- 2
  - (a) A significant number of candidates rewrote the question stem and answered in terms of needing one more Cl in each molecule with no explanation. Of those candidates who answered in terms of electrons a significant number omitted to include that the increasing number of electrons are in the outer shell.
  - (b) The bonding and structure in sodium chloride, magnesium chloride and silicon chloride were well known. All possible combinations of answers were seen for aluminium chloride.



- (c) Many candidates understood the nature of the bonding and forces in sodium chloride but some candidates discussed forces between ions within the molecules. A significant number of candidates compared the strength of ionic bonds to covalent bonds and many of these thought that silicon chloride would have the higher melting point.
- (d) The reaction of silicon chloride and water was well known. However, some candidates omitted to include an observation. The behaviour of sodium chloride in water was not well answered by a large number of candidates. Although candidates generally described the process as dissolving there was a clear misunderstanding of the term. Many candidates included fizzing in their observations and included an equation giving a variety of products, often sodium hydroxide and hydrogen chloride. Very few candidates appreciated that a colourless solution would be formed.
- 3 (a) Many candidates found the deduction of the oxidation numbers from the equation difficult, often including high oxidation numbers for H and an oxidation number of  $-2$  for O in hydrogen peroxide. However, many candidates could then use their oxidation numbers to describe oxidation and reduction correctly.
- (b) Most candidates multiplied the equations by the correct factors and added them together correctly. However, many omitted to cancel through the hydrogen ions.
- (c) Candidates laid out the calculation logically and showed clear understanding. However, a small number of candidates did not consider the relevance of significant figures and gave full calculator displays as their final answer.
- (d) The possible reagents and the colours they produce were well known but the fact that a precipitate was made with sodium hydroxide was frequently omitted, with some candidates thinking that a precipitate was made with thiocyanate ions.
- 4 Candidates found this question accessible and a significantly large proportion scored more than 7 out of the 15 marks available.

Only an extremely small proportion of candidates included transition elements other than copper in the ligand substitution sub-section in part **b**.

The best answers tended to be short and concise giving only one example each for the 3-D shapes and two examples for the ligand substitutions.

Most candidates were awarded a mark for Quality of Written Communication from correct use of two complete sentences in which the meaning was clear.

In part **a**, the electronic configuration of the copper ion was well known but a significant number of candidates either removed two 3d electrons leaving the 4s intact or removed one 3d electron and one 4s electron. Almost all candidates could explain why copper is a transition element.

The term *ligand* was well known but a significantly large number of candidates omitted to have a metal atom or ion at the centre of the complex ion.

Ligand substitution was well known with many candidates scoring well for the two examples. However, some candidates confused or omitted the overall signs on the complex ions or omitted the substituted ligand at the right-hand side of the equation. Some candidates reacted  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  or even  $[\text{Cu}(\text{H}_2\text{O})_6]^{3+}$  with  $\text{SCN}^-$ .

*Report on the Units taken in January 2010*

$[\text{Cu}(\text{H}_2\text{O})_4(\text{NH}_3)_2]^{2+}$  and  $[\text{CuCl}_4]^{2-}$  were also seen frequently. Most candidates could give the correct colours for at least two complex ions.

Most candidates could name two different shapes of complex ions and many could draw correct 3-D diagrams of both a tetrahedron and an octahedron. However, a significant number of candidates drew a 2-D representation of an octahedron or had three of one of the different bond representations such that the shape couldn't exist. Some candidates also gave incorrect examples of complex ions.

## 2815/02 Biochemistry

- 1 (a) (i) This part was well answered, except by a few who gave the molecular formula instead of the empirical formula.  
(ii) Most candidates knew that this referred to the orientation of the OH group on C1, above the ring.  
(iii) Half the candidates drew the correct structure with new aldehyde and hydroxyl groups. Others tried ketones, carboxylic acids or even ethers unsuccessfully. A few had only five carbon atoms.  
(iv) Most candidates found the hydroxyl group, but aldehyde was much less common even when one had been drawn in (iii).
  - (b) Most candidates knew that OH groups would be involved in hydrogen bonding. Only half of these were able to score the second mark for a diagram or for noting that several water molecules would be involved.
  - (c) (i) Nearly all showed the two glycosidic links in their structures. Only half were successful in handling the stereochemistry needed. Those who had glucose molecules climbing across the page found it easy because that does not require the middle glucose to be turned upside down. Many who tried to invert the middle glucose in a flat linear arrangement made mistakes in doing so.  
(ii) The majority of candidates knew that cellulose is a structural material.
- 2 (a) (i) Most found one of the OH groups, either on C3 of the ribose ring or attached to P. Few found both.  
(ii) Most recognised that the base uracil and the sugar ribose would only be found in RNA.  
(iii) Most candidates knew that hydrogen bonding holds the double helix together. Fewer stated that this arrangement holds the bases protected inside.
  - (b) Most candidates described translation as required, but a few wrote about replication or transcription by mistake. Most showed a good knowledge of the process and there were many sound accounts with accurate use of technical language. Weaker candidates without this technical language were less successful in producing satisfactory answers.
- 3 (a) The majority of candidates knew the structure of an ester group. The minority drew ketones or ethers, or attached the acids to propanetriol without using the alcohol groups at all. About a third of candidates were successful in drawing the full structure correctly. Some did not score the second mark because they gave a monoglyceride; others had the wrong chain length on their acids or omitted atoms from their structures.
  - (b) This proved difficult for most candidates. Some concentrated entirely on the lack of hydrogen bonding opportunities, often suggesting that there were none, rather than not enough. The more successful focussed on the opportunities for van der Waals' forces (instantaneous dipole-induced dipole forces) in the triglyceride and solvent separately and together. A substantial minority spoilt this approach by referring to 'hydrophobic' attraction. The term 'hydrophobic' is best reserved as a label for non-polar molecules and groups, and not for the attractive forces between them.
  - (c) All knew that triglycerides acted as storage molecules for energy in animals. Some tried the same answer for food stores for plants but without specifying that this usually happens only in seeds. Some recognised that triglycerides contribute to membrane structure around plant cells. Others were clearly confusing this role with that of phospholipids.

- 4** This question on proteins was answered well, with most candidates scoring half marks or better.
- (a)** Nearly all counted four amino acids.
- (b)** **(i)** Half the candidates suggested a peptidase or an enzyme such as trypsin. Protease was also acceptable, but not peptase or any digestive enzymes for carbohydrates or fats.
- (ii)** Hydrolysis with a named aqueous acid and heat was required. Several candidates left out one of these points and lost the mark.
- (iii)** Few managed the complete structure with both the COOH group and two  $\text{NH}_3^+$  groups. Often one was forgotten. Some drew a zwitterion. Others had the charges entirely the wrong way round.
- (c)** Nearly everybody drew a simple spiral for the helix, but some drew a double helix which does not apply here. About half drew a correct hydrogen bond, clearly between CO and NH groups in the polyamide chain. A substantial minority used side-chain (R group) interactions instead.
- (d)** **(i)** The great majority scored full marks. The only error was to refer to hydrophobic forces instead of van der Waals' forces.
- (ii)** This was nearly always correct.
- (e)** **(i)** This proved difficult for many, in some cases because candidates were unable to express their ideas clearly. Some referred to  $V_{\text{max}}$  as an explanation rather than something to be explained. Better candidates had short clear answers to the effect that the active sites become saturated with substrate.
- (ii)** The majority drew the correct curve, with the rate not returning to  $V_{\text{max}}$  at high concentrations. The minority drew the curve for competitive inhibition by mistake.
- (iii)** This was well done by most candidates, who referred to 'another' or allosteric site for permanent attachment of the inhibitor. This could change the shape of the active site sufficiently to reduce or stop activity.

## 2815/04 Methods of Analysis and Detection

### General comments

Candidates were generally well prepared for this module and had gained a good understanding of this area of chemistry. Candidates were able to deduce chemical structures from spectra of various types very well. Able candidates lost marks mostly through imprecise language or lack of detail.

### Comments on individual questions

#### Question

- 1 This question was often the weakest of all the questions for a significant number of candidates. In **a(i)** most candidates were able to identify the unfragmented molecule to be responsible for the molecular ion peak. Fewer candidates were able to explain that the base peak is the most abundant ion or the peak with the greatest relative abundance. Most candidates were able, in **a(ii)**, to explain that the molecular ion peak is missing because it has completely broken down. They were also able to identify a possible ion of  $\text{CH}_2\text{OH}^+$  as the ion responsible for the base peak at  $m/e = 31$ .

In **(b)** even the better candidates struggled to score highly. The question asked for one difference and one similarity for each of the three types of spectrum to be suggested and explained. Candidates very often did not address each part of the question, for example they often identified a peak on the mass spectrum for **A** but did not make any comment about whether it would or would not be present for propane-1,2-diol. Others gave two similarities but no differences. Some suggested that propane-1,2-diol would have an IR peak at  $2500\text{--}3300\text{ cm}^{-1}$  but did not explain what caused it (in this case the OH in COOH). Examiners were then unable to award full marks to these candidates because they had not answered the question.

- 2 This question was one of the major differentiating questions on the paper; weak candidates found it very difficult and good candidates were able to score well. Parts **(a)** and **(b)** were very poorly answered by weaker candidates. They were unable to interpret the information about melanin given in the question to draw a curve that absorbed from below the visible region, with a peak across the visible region that then dropped off after 700 nm. In **(b)**, expressing the definition of a chromophore in accurate language proved more difficult than examiners had expected since this is a core part of this topic that has often been asked before. In **c(i)**, most candidates were able to score at least half marks. Those that did not score the second mark often omitted detail such as the need for refluxing to be over a long time ( $>6$  hours). Part **c(ii)** was a very straightforward mark; candidates at all levels stated correctly that the technique is chromatography or electrophoresis. In **c(iii)**, the identification of a specific amino acid by use of  $R_f$  values was surprisingly not as well known as examiners had expected.

- 3 This question was straightforward for the full range of ability of candidates.

In **a(i)**, the majority of candidates were able to make a reasonable attempt at plotting the graph. Candidates must make sure that, when asked to perform this type of skill within an exam, they are careful, accurate and precise in the way they handle the data. For example, candidates lost marks for a variety of reasons including no or incomplete labels on the axes, not all of the points plotted or a point plotted incorrectly, no line or no straight line. Most candidates were able to read off the value of concentration for the emission reading of 28 from their graph and then to multiply it by 10 in order to calculate the

concentration of  $K^+$  ions in the blood. Those that made mistakes did so because they forgot that the value of this concentration from the graph was  $\times 10^{-3}$ .

In **(b)** many candidates were able to perform this very familiar calculation well. The most common errors were to incorrectly convert nm to m, to forget to convert the answer in J to kJ and to give a final answer to something other than the three significant figures asked for in the question. Many candidates gained full marks for the answer of  $296 \text{ kJ mol}^{-1}$ .

- 4 Weaker candidates found part **(a)** difficult, often being unable to express with any clarity their ideas about partition and adsorption. Partition should be explained in terms of movement between the two phases or different solubilities in the mobile and the stationary phases. Adsorption should be explained in terms of the affinity of a component for the stationary phase. Candidates commenting that components 'adsorb' differently are not explaining the term, merely restating it.

In **(b)**, most candidates were able to describe this familiar process. The stronger candidates were able to include more of the steps and in the correct order, whereas weaker candidates found it more difficult to remember every step and sometimes put them in the wrong order.

- 5 Examiners were very pleased to see that many candidates scored well on this question; for some weaker candidates it was often their highest mark. In **(a)** almost all candidates were able to correctly calculate the molecular mass using the four decimal place relative atomic masses given in the question to be 72.0936 for  $C_5H_{12}$  and 72.0573 for  $C_4H_8O$ .

In **(b)** many candidates were able to correctly identify the peak at about  $1720 \text{ cm}^{-1}$  as being produced by the  $C=O$  bond. They were also able to correctly discuss the peaks on the n.m.r. spectrum in terms of chemical shift values and the groups responsible, splitting patterns showing numbers of hydrogen atoms on adjacent carbon atoms and relative peak heights indicating the number of hydrogen atoms in that environment. This resulted in a significant proportion of candidates being able to identify **T** as  $CH_3CH_2COCH_3$ .

## 2815/06 Transition Elements

### General comments

This paper was completed to a very high standard by candidates mainly repeating the unit in the last year of this legacy specification. Clearly candidates had prepared well for this paper and they have benefitted from the back catalogue of past papers, mark schemes and examiner's reports which are available.

There were many good candidates who relished the opportunity to demonstrate their knowledge and it was pleasing to see the depth of understanding shown in some of the more difficult concepts. Calculations were well answered but in common with previous years there was an issue with the dilution factor. Chemical equations continue to cause problems.

### Comments on individual questions

#### Question 1

- (a) Too many candidates described ligand substitution using the word substitution. An alternative word was needed for the mark.
- (b) A majority of candidates can draw 3-D diagrams but there are still many non 3-D offerings.
- (c) This question proved to be difficult. Candidates were often imprecise about what is oxidised and what is reduced.
- (d) The oxidation states and colours of vanadium are well known.

#### Question 2

- (a) The oxidation state of sulphur was known by a majority of candidates. The calculation gave many candidates access to marks but weaker candidates particularly did not scale up to 250 cm<sup>3</sup> and lost 1 mark because of this.
- (b) Most candidates drew the 3:2 split for the d-orbitals but some left a vacant space in the lower level orbitals or simply showed no electrons at all. Lower and higher level orbitals do seem to confuse candidates and many candidates drew the d<sub>z<sup>2</sup></sub> orbital on the y-axis.
- (c) Most could name an alloy of copper and one of its uses.

#### Question 3

- (a) Most candidates scored marks for the diagram. Common mistakes included using bromine gas and not having a liquid level in the beaker. Many arrived at the correct equation for the cell reaction but explanations of redox were somewhat confused. Candidates must state clearly what is reduced and why.
- (b) A pleasing number of candidates understand the nature of electrode potential in helping to predict reaction feasibility. Answers used the idea of the cell potential being positive as well as the idea of potassium manganate(VII) being a better oxidising agent than chlorine but potassium dichromate(VI) being weaker.

#### Question 4

The calculation of the value of x in CrCl<sub>3</sub>.xH<sub>2</sub>O proved to be difficult for a number of candidates. Most candidates recognised that [Cr(H<sub>2</sub>O)<sub>4</sub>Cl<sub>2</sub>]<sup>+</sup> would show *cis-trans* isomerism although some thought it would show optical isomerism as well. Many candidates lost a mark by not stating that stereoisomers have the same structural formula but different arrangements in space.

The equilibrium between chromate(VI) and dichromate(VI) was well known but candidates lost marks because they did not clearly identify each formula when referring to the colour change. This was particularly problematic if the equation was written in the form dichromate(VI) → chromate(VI).

## 2816/01 Unifying Concepts in Chemistry

### General comments

This January series provided candidates taking the legacy Chemistry A specification with the opportunity to re-sit this unit. The entry of nearly 300 candidates was drawn from well over 150 centres.

There was a wide range of marks and there were no questions where candidates failed to score. Some candidates had prepared well for the unit but it was disappointing to see a large number of scripts with responses of a poor standard which presumably reflected an inadequate preparation.

### Comments on individual questions

- 1 (a) (i) Most candidates were able to write a correct expression for  $K_p$ , the commonest mistake being use of concentrations (square brackets) instead of partial pressures.  
(ii) Most candidates secured one mark for realising that the equilibrium position would lie towards the right, producing a greater proportion of products over reactants. Only the best identified that the large value of  $K_p$  reflected a far greater proportion of products over reactants.
- (b) (i) The majority of candidates identified that the equilibrium shifts in favour of the reactants, decreasing the partial pressure of  $\text{SO}_3$ . However, many did not explain the shift in terms of the  $K_p$  values at different temperatures.  
(ii) As with part (i), the majority of candidates identified the direction of the shift in equilibrium but many failed to explain the reason for the shift.
- (c) Most candidates were able to calculate the equilibrium partial pressure of  $\text{SO}_3$  as 4821 kPa. Far fewer were then able to calculate the percentage of  $\text{SO}_3$  as 97%.
- (d) (i) It was common to see a correctly balanced equation, with  $\text{ZnO}$  and  $\text{SO}_2$  as products. The commonest error was the formation of  $\text{Zn}$  instead of  $\text{ZnO}$ .  
(ii) Most candidates responded correctly in terms of greater availability.
- 2 (a) Able candidates could use the information in the question to construct a balanced equation. It was disappointing though to see many poor attempts, some showing the same reactants and the products.
- (b) As in previous papers, the majority of candidates had little problem in deducing an order for a simple example. Thus candidates could identify the order with respect to  $\text{I}^-$  with ease. Many fell down when tackling the order with respect to  $\text{H}^+$  ions as more than one variable had been changed. The other parts of the calculation were marked consequentially and produced few problems. The correct answer was  $0.15 \times 10^{-2} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ , with responses to either two or three significant figures, being accepted.
- (c) (i) Most candidates were able to construct this simple equation.  
(ii) This part caused problems for most candidates. Although many were able to show that 1.67 mol  $\text{O}_2$  had been produced from 1  $\text{dm}^3$   $\text{H}_2\text{O}_2$ , it was not apparent that many realised quite what they had worked out. Instead of simply doubling this value to obtain a concentration of 3.34 mol  $\text{dm}^{-3}$ , many manipulated the figure otherwise, often dividing by 40.



- 3 (a) (i) Many candidates had problems writing this equation and it was comparatively rare to see both a correct equation and correct state symbols.  
(ii) Although many obtained a correct amount of HI as 0.369 mol, it was comparatively rare to see the correct negative pH of  $-0.21$ .
- (b) (i) This part was usually answered correctly. Candidates should though answer such a question using the acid in the question rather than using the formula of a generic acid (*i.e.* HA).  
(ii) Weak acid pH calculations are now becoming routine and most candidates correctly calculated the pH as 3.67.  
(iii) This part proved to be the most difficult part of (b) with many candidates seemingly having little idea of conjugate acid–base pairs. Amongst those with some concept that a proton is transferred, it was common to see the proton transferring from ethanoic acid rather than from the stronger hydroiodic acid.
- (c) (i), (ii) For most candidates, these proved to be easy marks.  
(iii) Buffer calculations continue to cause problems, with many repeating the ‘square root’ method for a weak acid calculation. This was surprising as it is very unlikely that two similar pH calculations would be set on the same examination paper. Better candidates attempted to use the standard method for a pH buffer calculation. The successful candidates obtained the correct pH of 4.20 although it was common to see 3.40 from an inverted acid/base ratio or an incorrect sign in the Henderson–Hasselbalch equation.
- 4 (a) The initial part of this question was reasonably well answered and a large number of candidates were able to calculate the molar mass of the acid. Some candidates failed to take into account the factor of 4 linking the 25 cm<sup>3</sup> volume of solution used with the total 100 cm<sup>3</sup> volume of the solution. Most of the candidates who calculated the correct molar mass of 114 g mol<sup>-1</sup> proposed a carboxylic acid with six carbons although a significant number forgot that they were aiming for an unsaturated acid as stated at the beginning of the question. Some candidates identified *cis-trans* isomers instead of structural isomers. The mark least often awarded was the molecular formula for **A**.
- (b) Most candidates made easy work of the rate–concentration graphs, the majority being credited with full marks for this part of the question. The responses for the acid–base titration pH curves were disappointing with many poor sketches being seen. It was common to see unlabelled pH axes so it was not possible to see the pH range over which the pH was changing rapidly. Some candidates did not read the question and sketched pH titration curves for every combination of strong and weak acids and bases.

## **2816/02 Unifying Concepts in Chemistry (Coursework)**

### **General comments**

The work of less than 50 candidates was submitted for moderation. It was pleasing that it appeared from the scripts received that many candidates had taken the opportunity to improve the quality of their work quite significantly. Occasionally a very high standard was reached. Generally the marking was carried out accurately but not all centres provided sufficient information to explain why a particular level had been awarded. Annotation of the scripts is a very helpful way to explain the decisions taken and is much appreciated by the Moderators.

The marks for Skill P (Planning) were sometimes rather generous. For example, in the instructions, candidates are quite clearly advised to give detailed references within their Plans and failure to do so inevitably means that P7a cannot be credited. In the rate experiment, the results from the teacher demonstration must be mentioned and an explanation of how this affected the subsequent Plan is required for the award of P7b.

Candidates carried out the experiments used to assess Skill I (Implementing) well and this was normally accompanied by reliable observations. The high marks obtained were usually justified. Skill A (Analysis) was not always so successful but teachers had marked this skill reliably.

Skill E (Evaluation) is the most difficult of the skills and quite low marks are often appropriate even though high marks have been obtained elsewhere. There were several cases where the marks awarded by centres seemed to have been inflated to match the quality of the other skills. The Moderators, of course, applied the marking criteria rigorously and this occasionally led to an adjustment to the marks submitted. A particular point to note is that, to award E5b, a candidate must have identified the error that is the most significant for the experiment that has been carried out. In some cases [such as the analysis of iron(II) sulphate or copper sulphate crystals] this may require a comparison to be made between the results obtained and the expected result. In other cases it may be necessary to identify results that are anomalous.

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

### General comments

The number of candidates for this examination was small but there were some extremely good scripts. Centres are reminded that supervisors need to supply a set of results to enable the marks for accuracy in that part of the practical to be applied with confidence. Candidates had no difficulty in completing this practical test within the time allowed. In general, the candidates' performance on the Evaluation section was better than usual, probably reflecting the very high percentage of candidates who were re-sitting the paper.

### Plan

Marks on this exercise were a little lower than usual. Many candidates did not give necessary detail when describing how to separate accurately the iron and copper and a few candidates did not realise that to do so was necessary. Failure to mention use of excess acid to dissolve the iron, to calculate how much acid would be needed, or to give any accuracy precautions while filtering off the copper were common.

The redox titration with potassium manganate(VII) was generally described well, although some accounts failed to mention the need to acidify the iron(II) sulphate solution before titrating.

For their second method, a few candidates failed to read the question, which required a gravimetric procedure involving weighing an iron compound. Reacting the iron to precipitate copper was therefore not a suitable method, nor was collecting hydrogen during the reaction with an acid. A number of different valid procedures were suggested by candidates. The most popular method was precipitation of iron(II) hydroxide although many candidates suggested crystallisation of the iron(II) sulphate obtained after reacting the mixture with acid. Again, in this section, many accounts lacked sufficient practical details, such as using an excess of the precipitating agent or drying the residue obtained to constant mass.

### Test

The potassium manganate(VII) titration was performed very accurately by most candidates, although there were one or two candidates who, by recording their weighings incorrectly, denied themselves the possibility of scoring any of the six marks awarded for accuracy. In the safety question, candidates were expected to relate their precautions to one of the hazards stated on the question paper.

The first half of the calculation was generally done well, although many candidates gave the concentration of  $\text{KMnO}_4$  as  $0.018 \text{ mol dm}^{-3}$ , ignoring the instruction to quote answers to three significant figures. The second part of the calculation proved to be more demanding and only the more able candidates were able to complete it successfully. Omission of the scale-up factor to allow for the dilution of solution of the iron(II) salt was, as usual, a fairly common error.

In the second of the test-tube tests, most candidates were unable to explain why they obtained a brown precipitate. Only the most able candidates were able to give a correct explanation in terms of the oxidation of iron(II) ions.

The first section of the Evaluation proved straightforward for most candidates but the second proved far more demanding. Many candidates realised that a balance reading to three/four decimal places would increase the accuracy for an experiment involving such small masses.

*Report on the Units taken in January 2010*

However, few realised that, since NaOH was in excess, its volume did not need to be measured accurately. No candidate appreciated that the volume of water used was of no importance at all.

In the third section, marks were credited for a wide range of suggestions including using larger masses, improving the filtration, the possibility of oxidation of the residue and full drying of the residue. Unfortunately, many candidates focused on the alleged inaccuracy of measuring the volumes. The final section was well answered by many candidates, and it was encouraging that 'reliability' was discussed better than in the past.

# Grade Thresholds

Advanced GCE Chemistry (3882/7882)  
January 2010 Examination Series

## Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
<b>2814</b>	Raw	90	69	61	54	47	40	0
	UMS	90	72	63	54	45	36	0
<b>2815A</b>	Raw	90	74	67	60	53	47	0
	UMS	90	72	63	54	45	36	0
<b>2815C</b>	Raw	90	74	67	60	54	48	0
	UMS	90	72	63	54	45	36	0
<b>2815E</b>	Raw	90	75	68	61	54	47	0
	UMS	90	72	63	54	45	36	0
<b>2816A</b>	Raw	120	97	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
<b>2816B</b>	Raw	120	97	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
<b>2816C</b>	Raw	120	89	78	68	58	48	0
	UMS	120	96	84	72	60	48	0

## Specification Aggregation Results

Overall threshold marks in UMS (*i.e.* after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
<b>3882</b>	300	240	210	180	150	120	0
<b>7882</b>	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>	4.5	9.1	27.3	54.5	100	100	23
<b>7882</b>	12.3	46.4	71.6	88.9	97.2	100	578

**601 candidates aggregated this series.**

For a description of how UMS marks are calculated see:

<http://www.ocr.org.uk/learners/ums/index.html>

Statistics are correct at the time of publication.

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