

# CHEMISTRY

**Paper 9791/01**  
**Part A Multiple Choice**

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	<b>C</b>	21	<b>D</b>
2	<b>B</b>	22	<b>D</b>
3	<b>C</b>	23	<b>B</b>
4	<b>B</b>	24	<b>C</b>
5	<b>B</b>	25	<b>C</b>
6	<b>B</b>	26	<b>B</b>
7	<b>C</b>	27	<b>A</b>
8	<b>B</b>	28	<b>B</b>
9	<b>A</b>	29	<b>D</b>
10	<b>C</b>	30	<b>B</b>
11	<b>D</b>	31	<b>D</b>
12	<b>C</b>	32	<b>B</b>
13	<b>B</b>	33	<b>A</b>
14	<b>B</b>	34	<b>D</b>
15	<b>A</b>	35	<b>C</b>
16	<b>D</b>	36	<b>D</b>
17	<b>D</b>	37	<b>A</b>
18	<b>A</b>	38	<b>D</b>
19	<b>B</b>	39	<b>C</b>
20	<b>C</b>	40	<b>B</b>

## General Comments

The paper consisted of 40 questions which involved choosing a correct answer from a choice of four.

Knowledge of syllabus **sections A2.1** and **A2.2** (Questions 10 to 17) was good, but candidates were less confident with **Questions 37 to 40** on spectroscopy (syllabus **sections A4.3** to **A4.5**).

## Comments on specific questions

The eight easiest questions were **5, 11, 13, 17, 21, 25, 28,** and **29**. These were non-calculation items often needing only one piece of factual knowledge to get to the answer.

The six most difficult questions were **6, 14, 18, 26, 31,** and **40**.

In **Question 6** the distractors A, C and D were equally common suggesting candidates could not recall the energy order of the orbitals.

In **Question 14** candidates were expected to apply their knowledge of syllabus **section A2.2(a)**. Many mistakenly felt charge density of the anion was a factor.

The most common incorrect answer in **Question 18** was B, suggesting many candidates could not recall the correct balanced equation between thiosulfate ions and iodine.

**Question 26** needed candidates to apply their knowledge of syllabus **section A3.2(h)** to the information given, when only key B would produce a product without two hydroxyls on the same carbon atom.

**Question 31** proved the most difficult question of all. The majority of candidates did not realise that two adjacent carbon atoms were needed with a hydrogen atom and a bromine atom on them for the elimination to occur.

In **Question 40**, many candidates gave distractor C, not realising there was no alcohol OH absorption in the infra-red spectrum.

# CHEMISTRY

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Paper 9791/02  
Part A Written

## Key message

Many candidates could improve their performance in the problem-solving exercises by further scrutinising the wording of the question, from which one can often mine many hints about how to proceed. It is also worthwhile considering the wider question: earlier parts tend to cue the candidate into the correct mind-set for tackling a problem at the end of a question.

## General comments

Candidates generally coped well with the paper. Like last year's Paper 2, questions usually contained parts where unfamiliar material needed to be rationalised using theory from the syllabus. The final practical question was possibly less demanding than last year's and was answered well. Perhaps because of this, fewer candidates seemed to suffer from time pressure compared to last year.

## Comments on specific questions

### Question 1

This question tested candidates' knowledge of atomic orbitals and how their shapes lead to different types of overlap.

- (a)
- (i) Candidates were most successful at identifying the s and p orbitals. The subscript labels on the d orbitals caused the most difficulty.
  - (ii) Candidates easily managed this task.
- (b)
- (i) Some candidates used  $p_x$  or  $p_y$  orbitals for this question. This may have been because of their association of the  $p_z$  orbital with  $\pi$  bonding in ethane. Candidates needed to follow the guidance in the question about the relative positions of the axes and to apply the idea of the different modes of overlap.
  - (ii) Some candidates used the  $p_z$  orbital for the reasons described in (i).
- (c)
- (i) This question was done well. A few candidates did not use subscripts to indicate the number of electrons in each subshell.
  - (ii) A significant number of candidates answered this question successfully.
  - (iii) Again, many candidates successfully interpreted the novel context of this question and worked out the correct orbitals.

### Question 2

This question tested candidates' ability with thermochemical calculations, and rationalising a surprising result in terms of bond energies.

- (a) Most candidates successfully calculated the magnitudes of the total bond breaking and bond making. A common error was to apply the wrong sign to the processes.

- (b)
- (i) This question was answered well.
  - (ii) Most candidates realised that catalysis was involved. More able candidates could describe its mode of catalysis and stated that the catalytic mechanism lowers the activation energy.
- (c) This surprising result was successfully interpreted by many candidates in terms of polarity.
- (d) This demanding question was successfully tackled only by the most able. Weaker candidates repeated arguments from (c).

### Question 3

This question tested candidates' knowledge of the van Arkel triangle, and extended into considering its limitations.

- (a) Nearly all candidates successfully plotted the points in the triangle. In a few cases where the use of lines parallel to the triangle's edges was carried out hastily, the plotted points were too far from their true values to gain credit.
- (b) Nearly all candidates answered this part correctly.
- (c) Nearly all candidates answered this part correctly.
- (d) Most candidates answered this part correctly.
- (e) Most candidates answered this part correctly.
- (f) Successful candidates were guided by the information in the question to the three marking points. It is important in this question to be very precise, since the bonding triangle as a concept does not require the stoichiometry of a binary compound, while a failing of the triangle is that it cannot differentiate between compounds of the same two elements but combined in *different* stoichiometries, *i.e.* different oxidation numbers.

### Question 4

This question tested candidates' knowledge of main group inorganic chemistry, and included links to organic chemistry with the hydrolysis and condensation reactions. These concepts were extended to the point where candidates could attempt a difficult problem involving the formation of diphosphate esters.

- (a)
- (i) Candidates were more successful at naming the shape and giving the bond angles than they were at drawing the shape of the molecule in a physically reasonable way. Calling the molecule pentagonal bipyramidal was a common error.
  - (ii) A common error was to call the reaction just substitution, whereas this hydrolysis was substitution followed by elimination.
  - (iii) Most candidates answered this part correctly.
  - (iv) Stronger candidates realised that concentrated sulfuric acid is also oxidising; many candidates were distracted by the fact that phosphoric acid has more hydrogen atoms and is a weaker acid.
  - (v) Nearly all candidates answered this part successfully. Care needs to be taken so that the atoms are ordered in a physically realistic way, *i.e.* HO<sup>-</sup> and -OH but not OH<sup>-</sup> or -HO.
- (b)
- (i) Most candidates answered this part successfully though a few omitted to balance the equation.

- (ii) This part of the question involved applying the methodology of hydrolysing organic molecules to an inorganic compound. More able candidates could see this link while others sometimes completed the reaction in a single step.
- (c)
- (i) Most candidates were able successfully to follow the guidance in the question.
- (ii) This part was generally answered correctly.
- (iii) Only more able candidates could deal with this greater level of generalisation.
- (d)
- (i) Some candidates wrote molecular formulae rather than empirical formulae; a few wrote a repeat unit, *i.e.* CHO<sub>n</sub>H<sub>n</sub>, which is not quite how an empirical formula is defined.
- (ii) This very challenging question was successfully completed by only the most able. Credit was given to answers that correctly connected diphosphate groups between adjacent oxygens on the inositol ring. Some candidates placed charges on the phosphorus atoms or incorporated additional oxygen atoms around the phosphorus atoms.

### Question 5

This question tested candidates' knowledge of Grignard chemistry. Candidates were later required to apply the principles from Grignard chemistry to synthesis of dendralenes, an unfamiliar class of molecules.

- (a) This part was answered correctly by most candidates.
- (b) Most candidates realised that Grignard reagents are nucleophiles. Some weaker candidates included contradictory answers, like acid and base.
- (c)
- (i) The organic product (the alcohol) was the intended answer, though credit was given for the intermediate magnesium salt. Most candidates were able to ascertain the connectivity of the carbon skeleton in the product.
- (ii) This part was answered successfully by most candidates.
- (iii) Some candidates named the molecule as having a hydroxyl branch, or assigned carbon 2 to the methyl branch. Credit was only given to correct assignment of carbon 2 to the functional group and carbon and the description of the molecule as a derivative of butan-2-ol.
- (d) Propan-2-ol was a common error. More able candidates followed the guidance in the question that suggested that the  $\delta^+$  hydrogen of water would connect to the  $\delta^-$  carbon of the Grignard reagent.
- (e)
- (i) This part was answered correctly by most candidates. Common errors included miscounting the number of hydrogen atoms by one. Candidates would be well advised to bear in mind that any hydrocarbon molecule will have an even number of hydrogens (except radicals).
- (ii) Due to the rotation of single bonds there was more than one permissible conformation of the structure, and candidates mostly identified one. Some candidates seemed to forget to include the inorganic by-product.
- (iii) Only more able candidates could apply the general concept to the dichloroalkene, and again there was more than one permissible conformation of the product. Many just reacted one of the chlorine atoms, and so gained partial credit.

### Question 6

This problem-solving question tested candidates' ability to apply data from quantitative and spectroscopic analysis, together with some other clues, to establish the structure of unknown molecules and ions. The last part of the question involves simple amount calculations but on an unusual scale.

- (a) Candidates were more successful at identifying **A** and **B** than they were **C**. Some candidates included a double bond in the three-membered ring or bonded the wrong number of hydrogen atoms to the ring.
- (b)
- (i) Many candidates answered this part correctly. Common errors were representing all three O–H bonds in the same way and not showing the positive charge anywhere.
  - (ii) This part was answered well by many candidates. Some candidates thought the molecular ion had a mass one unit lower than the formula suggested. A common error was to think that the three-fold symmetry of the ion leads to only a single signal in the  $^{13}\text{C}$  spectrum.
  - (iii) Apart from the stability of molecule, the data was consistent with three 3-membered rings bonded to the central oxygen so credit was given for this answer, which was more common than the correct macrocyclic structure.
- (c)
- (i) Most candidates answered this part successfully.
  - (ii) Most candidates answered this part successfully.

### Question 7

This question was mainly about planning a calorimetry experiment, and evaluating it. Preliminary parts tested candidates' ability at calculating an enthalpy change of formation from combustion data. The most challenging part of the question was applying a multiplicative correction factor to calibrate the experiment using a data book value. The question also considered the physical properties of certain molecules or functional groups and how these affect combustion.

- (a) Candidates were less successful in answering this part than had been anticipated.
- (b)
- (i) Candidates generally wrote the correct balanced equation. A common error was not to take into account the oxygen atoms in the ester when deciding how many  $\text{O}_2$  molecules to include on the left hand side of the equation.
  - (ii) This was generally answered well.
  - (iii) Candidates who used 2 moles of ester in their balanced equation (so that there was an integer number of  $\text{O}_2$  molecules) sometimes ran into difficulties with stoichiometry in this part. In some cases their answers were twice the correct value.
- (c)
- (i) Most candidates performed well on this part. A few dealt more with the theory rather than the practical steps and so gained less credit. An important consideration is measurement by difference, which applies both to the mass of ester and the temperature of the water in the copper can.
  - (ii) This calculation was done correctly by many candidates, who realised that the copper from the can, being a good conductor of heat, will have experienced the same temperature increase as the water inside the can.
  - (iii) Most candidates realised they needed to use the data book value for the combustion of the ester to work out the theoretical amount of heat energy evolved.
  - (iv) This part differentiated well across the ability range. Nearly all candidates gained credit for calculating the amount in moles of ester, and most used their heat change and this amount to arrive at a negative molar enthalpy change of combustion. The more challenging part was the calibration. Few candidates thought to find a calibrated heat capacity for the apparatus by dividing the theoretical heat produced from the first ester by the observed temperature change. A more common strategy was to calculate an uncalibrated heat change from the copper can and the water and then to correct this to take into account heat loss. Some

candidates only considered the heat change in the water, omitting the copper can, and so lost credit. It was incorrect simply to add the difference between the theoretical and observed heat changes from the first ester because the temperature change was not the same in the second case. The correction would need to be scaled by 11.5 K / 10 K. The more able candidates found a multiplicative correction factor using 21.1 kJ / 13.5 kJ.

- (d) Nearly all candidates gained some credit with mention of lids, stirring or insulation. Candidates who mentioned stirring in **(c)(i)** gained further credit in this part (up to a maximum of full credit). Wholesale changes to the method or those that would be impractical to implement were not given credit.
- (e) A likely error in many cases was to compare the esters in the opposite sense to the wording of the question and not to make it clear which ester was being referred to. Generally the question was answered successfully though.

# CHEMISTRY

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Paper 9791/03  
Part B Writing

## Key Messages

Success in this paper requires careful application of learning to the context of the question with, in particular, appropriate use of data given. A combination of specific recall of key ideas, as defined in the syllabus, together with the ability to apply ideas to more unfamiliar situations will be the mark of a successful candidate. The ability to explain ideas clearly is also crucial so as to avoid ambiguity in responses.

## General comments

The best responses were distinguished by their clarity where explanations were required, notably in **Questions 1b(ii), 4d(i), 4d(ii) and 4f** where the questions specifically asked for references to data given. Weaker candidates tended to offer generic responses in these situations rather than making specific references to supporting data.

## Comments on specific questions

### Question 1

This question tested candidates' knowledge and understanding of basic ideas related to both equilibria and kinetics. It combined recall and application of ideas.

- (a) Most candidates answered (i) well, with only a few not mentioning 'equilibrium' and thus not receiving any credit. In (ii) the inclusion of square brackets was the most common mistake but the question was generally well-answered.

The key in (iii) was the explanation with no credit available for simply stating that the forward reaction is endothermic. Recognising that  $K_p$  increases with increased temperature and that therefore the equilibrium must have shifted to the right was the key. In (iv) most candidates earned full credit but some were too vague, suggesting that the position of equilibrium would not change *much* or words to that effect.

- (b) Candidates' sketching abilities in (i) showed a wide variation. Axis labels were only occasionally wrong and the key ideas were for both lines to start at the bottom left axis junction, not to meet the x-axis on the right and for the peak of the  $T_2$  line to be below and to the right of the  $T_1$  line.

In (ii) the instruction in the question was to 'use the curves'. This was a situation where many candidates ignored the instruction and offered more generic answers. Many candidates only earned partial credit through stating that there would be more molecules with energy equal to or greater than the activation energy. The intention was for this to be supported by reference to the area under the curves to the right with a labelled activation energy and then to be developed to indicate a resulting increase in the proportion (or number) of *successful* collisions. Some candidates' answers indicated that they thought the *total* area under the curve changed.



## Question 2

This question, based on gases, tests an area of the syllabus that is not commonly seen on other syllabuses at this level and was probably the weakest question on the paper in terms of the general quality of responses seen.

- (a) There was some inevitable confusion between Boyle's Law and Charles's law but most candidates recalled this relationship.
- (b) Throughout this section it was essential for candidates to distinguish between the total volume of the gas and the volume of a particle of the gas.

As only two properties were asked for in (i), the key was to relate the answer to the context so that the appropriate ones were chosen that could explain the deviations evident from the graph given. Most candidates found the volume calculation in (ii) straightforward although a common oversight was the need to convert the answer from  $\text{m}^3$  to  $\text{dm}^3$ .

Part (iii) was an example of a situation where the choice needed to be very specific to the context with forces of *repulsion* (or volume of *particles*) needing clear reference. Following this the majority of candidates did not gain further credit as the inference was most often made that the volume increased as opposed to making the point that it failed to decrease by as much as it would in an ideal situation. In (iv) most candidates recognised that the particles were in order of size but did not develop the response to explain that the (non-ideal) volume effect would be greatest when particle size was greatest.

- (c) Again, specificity was needed with the idea that the deviation is explained by forces of *attraction* producing a *greater than ideal* decrease in volume; not just 'a decrease'.

## Question 3

The preamble to the Physical Chemistry section of the syllabus and B1.5q both mention the idea of the fuel cell, hence its choice as the basis of the first four sections of this question. Part (e) develops as a 'more conventional' electrode potential and Free Energy question.

- (a) Most candidates had no problem correctly selecting the particle names although some only gave 'ions' for **B** without being more specific.
- (b) Almost all responses here were correct although there were a few confusions with catalysts for other processes.
- (c) There were two common sources of confusion here. The first was an incorrect choice of equation for the cathode reaction; despite the clue in the diagram, a half-equation showing the production of  $\text{OH}^-$  was often seen. The second was the equations being given wrong way round. An often seen source of confusion is probably the cause of this, with many candidates at this level being more familiar with electrolytic cells than Galvanic cells and thus incorrectly assuming that a cathode is always negative. Candidates would do well to remember that reduction always occurs at the cathode while oxidation always occurs at the anode.
- (d) The key to success in (i) and (ii) was again to make the answer specific to the context, i.e. to the idea of using a fuel *in a motor vehicle* as an alternative to using *fossil fuels*. Long lists of more generic pros and cons can be found but those on the mark scheme are those specific to this context. Many responses seen here were too generic, too vague or (a common problem) restated a single idea rather than identifying a second point in each case.

- (e) Conventional notation was not well remembered in (i) with many candidates putting the Zn(s) and Zn<sup>2+</sup>(aq) the wrong way round and/or unnecessarily including an additional electrode (usually of Zn but sometimes Pt). The species were usually correctly identified in (ii) although 'silver' or 'Ag' or 'Ag<sup>+</sup>' were not specific enough for the reduced species where Ag<sub>2</sub>O was required. The equation in (iii) was usually well done although some candidates got it the wrong way round or forgot to balance correctly (despite the balancing having been included in the given half of the cell diagram). Parts (iv), (v) and (vi) gave most candidates the opportunity to demonstrate their competence at calculations based on familiar expressions. The only error seen with any regularity was not converting the Free Energy value from (v) into J mol<sup>-1</sup> for use in (vi).

#### Question 4

This was primarily a recall-based question on lattice structures with an 'add-on' of some iron-based chemistry.

- (a) There were surprisingly few correct responses to this recall question. The frequency with which '6' was offered presumably reflects confusion with ionic lattices. Some candidates felt the need to qualify their answer, e.g. "12 in hcp", which, although allowed, did seem to imply that they thought it was different in ccp as opposed to recognising that all close-packed metal lattices, by definition, have a coordination number of 12.
- (b) Most candidates made the correct choices and associations here. Although 'ccp' and 'hcp' were allowed, candidates must beware of using abbreviations when 'names' are asked for in a question.
- (c) Again these ideas were well remembered by most candidates.
- (d) Candidates need to take care to read a question carefully, especially when a question asks for comparisons and/or trends to be explained. In (i) there was no relevance to any mentions of silver, with the focus being purely on the sodium halides and their generally good agreement between theoretical and experimental lattice energy values. However, this part was generally well answered.

This was not the case to the same extent in (ii). Good advice to candidates is to try and follow the steps of a question, such that a good answer here would be expected to be a clear statement of what the trend actually is (with, again, the focus in the right area – namely the silver halides, so no mention of sodium is relevant here) followed by the explanation. Very few candidates were able to extend their explanation to a mention of the greater polarisability of the larger anions.

- (e) In (i) almost all candidates were able to recall the name of haemoglobin and almost all candidates also earned credit in (ii) through recalling that ferritin is involved in the storage of iron or the regulation of iron levels in the body. Further credit, for being aware of the ferroxidase activity of ferritin, in that it takes up iron as iron(II) but stores it as iron(III) was gained by very few.
- (f) The responses to this question indicated that the context was less familiar than expected and many candidates gained little credit. Once again the instruction given in the question to refer to the data given is key, with the ideal answer needing to begin with a clear statement of interpretation of the electrode potential value(s), followed by an explanation of the effect that the addition of acid would have on this comparison.

As a general comment it is vital for candidates to be able to discuss electrode potentials in terms of the principles of equilibria and, indeed, to appreciate that an electrode potential is an indication of relative equilibrium positions.

#### Question 5

This was a fairly typical organic chemistry question aiming to test familiar chemistry albeit in a probably unfamiliar specific context. It is to be hoped that candidates will be able to apply concepts learned using simple examples to more complex structures such as these.

- (a) The functional group level names were generally well remembered with only a few candidates offering 'carbonyl' for carbon 2.

- (b) This section was also well answered in most cases with most candidates recognising that the functional group had not changed, that the product contained the functional group after which the level is named and therefore that the reaction should be classified as hydrolysis – as in syllabus statement **A3.2(f)**. Only a few candidates incorrectly identified the process as substitution.
- (c) There was a wide variety of responses seen here with the greatest uncertainty being around the  $\text{-NH}_2$  groups. Very few candidates who recognised the correct products, recognised the additional need to protonate the  $\text{-NH}_2$  groups.
- (d) Most candidates could count correctly although a few did not present the answer as a true molecular formula.
- (e) The bromination product was well recognised with the second product involving esterification of the  $\text{-COOH}$  group nearly as well recognised. However, the product resulting from treatment with excess ethanoyl chloride was only occasionally correct. Many candidates producing an ‘almost correct’ response made the mistake of also ‘acylating’ the  $\text{-OH}$  of the  $\text{-COOH}$  group.
- (f) This caused few problems.
- (g) The mechanism was correctly named by most candidates and the two structures were also usually correct. In **(iii)** most candidates earned credit for the idea of the more favourable product being that derived from the more stable carbocation but few were able to explain this in terms of the reduction in positive charge density being the origin of the increased stability.

#### Question 6

Although primarily organic in focus this question also gave the opportunity to incorporate testing of ideas related to the strengths of weak acids

- (a) The mechanism was correctly identified by most candidates
- (b) Many good attempts at the mechanism were seen with the instructions to include all necessary curly arrows, lone pairs and charges helping to avoid many of the common omissions. Confusions were seen with regard to the distinction between full and partial charges, which end of the CN was responsible for the attack on the carbonyl carbon and which direction a curly arrow should ‘point’. In **(ii)** most candidates recognised that the lack of optical activity was due to formation of a racemate although there were some suggestions that there was no chiral centre in the product.
- (c) Part **(i)** and **(ii)** were well done but many answers to **(iii)** suffered from a lack of clarity and focus. Once again the question directed candidates to the data given and a clear reference was expected followed by a concise explanation. The phrase ‘dissociates more easily’ or similar was taken to be equivalent to the idea of the O-H bond weakening and a separate statement was needed about greater dissociation (or a shift in equilibrium position to the right). Many candidates also did not recognise that, as a trend was being explained, a good answer should have referred to the electron-withdrawing ( $-I$  – although this was sometimes incorrectly referred to as  $+I$ ) effect being *greater* the *more* chlorine atoms there are attached to C2.
- (d) The definition in **(i)** was well known. The commonest error in **(ii)** was to refer to the basis of the CIP rules being the mass, atomic mass or mass number of the substituents rather than the atomic number. Credit could not be awarded if candidates were not clear about the orientation (H into the page) that was needed before the judgement was made or if candidates simply stated that the groups appeared in a clockwise direction without being specific about which groups in which order. Parts **(iii)** and **(iv)** saw many candidates being awarded full credit.

# CHEMISTRY

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Paper 9791/04

Practical

## Key Message

Greater preparation is needed to improve candidates' ability to analyse the sources of error within an experiment and to suggest suitable improvements.

## General Comments

It was clear from the overall quality of the scripts that candidates had prepared well for this exam and in the main were able to work carefully through the practical tasks ahead of them and to record their results appropriately. One area that did emerge where perhaps greater preparation was needed was in candidates' ability to analyse the sources of error within an experiment and to suggest suitable improvements. There was no evidence from the scripts that any candidate had encountered difficulty in completing the paper in the time available.

In relation to the conduct of the exam, it should be stressed how important it is that Centres follow closely the requests made in the Confidential Instructions under the heading 'Responsibilities of the Supervisor during the Examination'. Centres are thanked for their diligence in providing the Supervisor Results requested and for reporting any difficulties encountered on the form attached to the Confidential Instructions. The use of this form ensures that candidates will not be placed at any disadvantage as a result of faulty chemicals or apparatus.

## Comments about specific questions

### Question 1

- (a) In general candidates recorded their results carefully using appropriate headings and including units. A handful of candidates recorded the volume at which they had added the starch indicator. This is, of course, unnecessary and can lead to errors when the final titres are being calculated. Hardly any candidates did not record the titration readings to the correct level of precision. Evidence of the skilled way in which the candidates had carried out the titration came from comparison of their results to those of the Supervisor which revealed a very pleasing level of agreement.
- (b) This presented candidates with no difficulty although a few, having noted their titres to the correct precision, then incorrectly rounded the value here to one decimal place.
- (c) This calculation involved a number of key steps. Virtually all candidates were able to convert the value they had calculated in (b) into an amount of thiosulfate and then use the stoichiometry of the given equation to arrive at an amount of iodine. They then successfully converted this into a concentration. The final step rested on noting that the sample with which they had been provided had been diluted six fold from that taken from the kinetics experiment. This final component of the calculation was the one most often omitted. Another error, although less common, was to give answers that were to fewer than three significant figures.
- (d) Almost all the candidates noted that the concentration of the iodine decreased by a fixed value for each equal interval of time and so were awarded credit. The second point for linking this to the fact that the order of reaction is zero with respect to iodine was awarded much less frequently. Many candidates appeared to confuse this graph of concentration against time with one of rate against concentration and so equated there being a straight line with a first-order reaction.

## Question 2

- (a) As with the results table in **Question 1**, this was well answered. Almost every candidate recorded their measurement of mass to a consistent number of decimal places depending on the balance they were using and, in addition, remembered to quote temperatures to the nearest 0.5 °C.
- (b) Although almost all candidates employed the appropriate expression for the heat given out, a small number substituted the wrong mass into the formula. In such cases candidates either used the mass of the zinc or they combined the mass of zinc and the mass of the solution.
- (c) This was very well done with the only significant error being from those who forgot to include the minus sign for this exothermic reaction.
- (d) As with (c), this was well handled although here again a significant minority forgot the minus sign.
- (e)
- (i) Apart from a very small number of candidates who misread the question and used their answer to (d) rather than the difference in working out the percentage, this question was very well answered.
  - (ii) Candidates found this surprisingly challenging and although many did gain credit, their answers were often a little confused and lacked clarity.
  - (iii) This uncertainty continued here where many candidates were not able to suggest a second improvement.

## Question 3

- (a) The majority of candidates had no difficulty here in obtaining the correct observations and deducing the identities of cations that matched their findings. Two points are worth noting. First, it is easier for the candidate in such tests if they set up their table with separate columns for recording the effect of excess of each reagent. Second, candidates must be careful not to use phrases that do not convey their observations such as 'a white solution' or 'a milky solution' in place of noting a white precipitate or a white solid.
- (b)
- (i) This was a relatively straightforward set of observations and all but the weakest candidates experienced no problems in gaining full credit.
- The overwhelming majority of candidates were able to identify correctly the ions present for (ii) and (iii).
- (c) The observations made in these tests were nearly always sound but candidates found linking these to the identity of **FA 9** challenging. Indeed this part was intended to stretch the most able candidates, requiring them to relate their understanding of functional groups to practical observation in order to reach a correct conclusion. The most common error was to suggest that **FA 9** was ethanal and that this was acidic enough to react with the sodium hydrogencarbonate. Some candidates clearly knew that methanoic acid may be oxidised while others impressed by their ability to reason this from its structure.