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# **GCE EXAMINERS' REPORTS**

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**GCE (NEW)  
CHEMISTRY  
AS/Advanced**

**SUMMER 2019**

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<b>Unit</b>	<b>Page</b>
UNIT 1	1
UNIT 2	7
UNIT 3	10
UNIT 4	16
UNIT 5a	21
UNIT 5b	23

# CHEMISTRY

## General Certificate of Education (New)

Summer 2019

### Advanced Subsidiary/Advanced

## UNIT 1 - THE LANGUAGE OF CHEMISTRY, STRUCTURE OF MATTER AND SIMPLE REACTIONS

### General Comments

The mean mark was 32.0 (slightly down from last year) and the highest mark was 74. In Section B the most successfully answered question as a whole was Q.9 with Q.12 being the least successfully answered. The easiest parts on the entire paper proved to be Q.9(b)(i), Q.12(a)(ii) and Q.9(a)(iii), while the hardest parts were Q.12(c), Q.10(b)(i) and Q.13(b)(i) in that order.

As noted in last year's report the examiners were disappointed with the standard of many of the answers given, especially the QER question, and too many marks are still lost in basic recall e.g. Q3, Q10(b), Q13(c)(i).

It was pleasing to note that good knowledge of mass spectrometry, radioactivity, oxidation numbers and origin of emission spectrum was shown by many candidates. However, the improvement shown last year in dot-and-cross diagrams did not continue.

Many candidates performed well in many familiar calculation questions e.g. Q10(c)(ii), Q12(a)(iii), Q13(b)(i). However, the calculations that were slightly different were poorly answered e.g. Q8, Q9(e), Q11(c). This shows that candidates' understanding of numerical concepts is still lacking in depth and many still have a difficulty in converting from one unit of measurement to another.

Once again bonding proved to be demanding for most candidates, Q9(d) on metallic bonding was poorly answered and Q13(b)(ii) and Q13(c)(i) on ionic and intermolecular bonding respectively were very poorly answered. These questions highlighted both a poor use of terminology and misconceptions with candidates referring to van der Waals forces and molecules when discussing metallic/ionic bonding.

### Comments on individual questions/sections

#### Section A

This section was disappointingly answered, with the mean mark being under 5 out of 10.

- Q.1** This dot-and-cross diagram question was supposed to be an easy starter. Although just over half gained both marks, just under a quarter drew a covalent molecule rather than an ionic structure and so failed to gain a mark. Others lost a mark for failing to show the outer electrons of the fluoride ion.
- Q.2** The majority of candidates attained this mark. The most common errors were reference to 'killing bacteria' or to 'healthy bones'.

- Q.3** Only around two-fifths of candidates gave a correct definition. The main error was to omit 'atom'.
- Q.4** Only around a half scored this mark. Many lost the mark for writing the electronic configuration for the sodium **atom** instead of the sodium ion.
- Q.5** Around three-quarters of candidates correctly identified the oxidation state of vanadium.
- Q.6** Around three-fifths gave the correct formula for magnesium phosphate.
- Q.7** Poorly answered. Around a third gave the correct answer. Most candidates correctly worked out the number of moles of carbon dioxide as 4 but failed to realise that this had to be multiplied by Avogadro's constant to find the total number of molecules.
- Q.8** The most difficult question in this section by some distance. Most failed to calculate the moles of oxygen. Many simply divided 3.68 by 16. While just over a third of candidates calculated the correct number of moles of titanium and oxygen for 1 mark, most failed to correctly convert this to the correct empirical formula of  $Ti_2O_3$ . Some did not realise that the moles of oxygen calculated referred to  $O_2$  molecules rather than O atoms and ended up with the incorrect formula of  $Ti_4O_3$ . Others rounded up too soon and ended up with TiO as their formula, again only gaining one of the two marks on offer.

## Section B

- Q.9** This question was the most successfully answered question in this section.
- (a) (i) Around two-thirds scored at least 1 mark here, identifying **C** as the correct atom. However, many candidates struggled to give reasons for their answer. Most incorrect efforts contained correct science, but lacked the detail required for the mark, e.g. they did not discuss/compare the second and third period atoms, stated 'it has less shielding' or 'full outer shell therefore greater nuclear attraction'. Some scored one mark for correctly identifying the general trends in ionisation energies of 'increasing across the periods and up the groups'.
- (ii) About four-fifths realised that **G** was the correct answer, and they found the explanation here far easier to put into words with over half gaining both marks. However, many seemed to think that the phrase 'highest effective nuclear charge' was the easiest way to score marks in these type of questions and they clumsily used this in both parts (i) and (ii).
- (iii) Very well answered. Most candidates scored both marks. Some candidates omitted one of the metals while others thought that **A** was also a metal. Few candidates failed to score one mark.
- (iv) Only just over a third realised that most metal oxides are basic. Since amphoteric properties are not dealt with at AS, anyone who included **E** in their answer was not penalised.

- (b) (i) The best-answered question on the whole paper. The vast majority knew that the atoms were bombarded by electrons to form an ion.
- (ii) Less than half the candidates gained this mark. Most either left out 'magnet' or 'deflect'.
- (c) Both parts were generally well answered with many gaining both marks. In part (i) the most common incorrect answer was  $^{28}\text{Na}$ .  
In part (ii) 10.5 hours and 28 hours were common incorrect answers.
- (d) This question on metallic bonding was fairly well answered. Over three-quarters gained at least one mark but only around one in eight scored all three. Many candidates obtained the mark for metal ions and delocalised electrons in a diagram. Quite a few scored the mark for the 'layers being able to slide over each other' from a combination of a diagram and written answer. Far fewer scored the mark for the attraction between the ions and electrons. Unfortunately, once again it was common to see references to ionic bonding and intermolecular bonding.
- (e) Poorly answered. This calculation was straightforward but only just over a quarter scored the mark. Most lost marks for giving an answer of 0.617 (failing to convert mg to g) or  $6.17 \times 10^{-7}$  (thinking that  $1 \text{ dm}^3 = 1000 \text{ litres}$ ). Some did not even change mass into moles.
- Q.10** (a) This question was generally well answered with most candidates recognising the need for an electron to be promoted to higher levels before then falling down to lower levels. Over half gained two marks and around three-quarters at least one mark. Marks were lost for failing to refer to 'electrons' (just using atoms) and only discussing electrons falling to lower levels.
- (b) (i) Very poorly answered. Many candidates were confused by the question and thought it referred to the number of different lines rather than different series. Consequently, they discussed the different energy levels that the electrons could be promoted to or fall from rather than the different energy levels to which the electrons could fall.
- (ii) More candidates understood that the energy levels got closer as they got higher, although some lost marks due their clumsy explanation of this point, e.g. 'the energy gets less big'.
- (c) (i) This scored fairly well with around a half recognising the ionisation energy concept of the convergence limit.
- (ii) This part of the question proved to be a good discriminator. While just under a half scored at least three marks, only around a fifth multiplied by the Avogadro constant to get full marks. Most picked up a mark for using the correct equations but many lost a mark by failing to convert nm to m. Around three in ten failed to gain any credit.

- (d) (i) This calculation was well done with over four-fifths gaining at least one mark and over a third gaining all three marks. The main error was incorrectly working out the molar ratio of aluminium to hydrogen. Those who used  $pV = nRT$  experienced difficulty with units and their conversion into  $\text{cm}^3$ .
- (ii) Just over half the candidates scored at least one mark. Some gained both marks even though they had not found the correct answer to part (i). ECF was applied and some used the alternative volume given in the question. A few lost one mark for not converting to kelvins. Again those who used  $pV = nRT$  struggled to convert  $\text{m}^3$  to  $\text{cm}^3$  and atm to Pa.

- Q.11**
- (a) Most correctly talked about 'fizzing stopping'. Others incorrectly referred to all the solid dissolving even though they were told that the mixture had to be filtered to remove solids.
  - (b) Very poorly answered. Only a few managed to score three or four marks. About a quarter managed to identify an improvement and gain one mark. Some explained the basis of it to score two marks. Many answers not worthy of credit referred to the accuracy of the titration and the apparatus, rather than focusing on the actual method provided.
  - (c) This back-titration calculation was poorly answered. Around two-fifths failed to score any of the four marks. Many did not even use the results of the titration and so could only score a maximum of one mark. Others did not use the original number of moles of acid and so could only score a maximum of two marks.
  - (d) This was well answered by most as they realised that the first titre was anomalous or non-concordant.
  - (e) Poorly answered. The most common answer stated that the titre went down rather than up, as the candidates did not realise that this was a back titration. Subsequently, around three-quarters failed to gain a mark.

**Q.12** This question was the least successfully answered question in this section.

- (a) (i) About two-thirds scored at least one mark here – realising that calcium gave a positive flame test. Dropped marks tended to be for weak or clumsy descriptions that lacked detail, e.g. 'calcium gives a red flame' (not brick-red) and 'it is slightly soluble' (not 'the hydroxide is slightly soluble'). Many discussed the carbonates but these were treated as neutral answers as all Group 2 carbonates are insoluble.
- (ii) The vast majority managed to name or provide the formula for calcium carbonate.
- (iii) A significant number of two-mark answers were seen but almost an equal number only scored one. These candidates correctly calculated the molar mass as 56 but failed to go on to show its relevance in identifying the metal as calcium.

- (b) Another good discriminator with most scoring at least one mark. While around a quarter of candidates gained all three marks a third failed to score a mark. Those who added the number of electrons to the neutrons lost a mark. Some also dropped a mark due to their final answer not being to four significant figures as the question requested. Those who only considered the masses as 70 and 72 scored a maximum of one mark.
- (c) This was very poorly answered and proved to be the hardest part on the whole paper. Some used the flow diagram from (a) to help provide a route for the formation of magnesium carbonate by adding magnesium to water then reacting with carbon dioxide. These candidates were awarded up to four marks depending on the accuracy of both relevant equations and practical detail (as magnesium does not readily react with water). Very few candidates competently reacted the magnesium with acid then added a soluble carbonate to precipitate out the required magnesium carbonate. Some gained one or two marks for suggested routes that could be the start of a competent process, but many made no attempt. Around three-quarters failed to score a mark.
- Q.13** (a) (i) Over two-thirds of candidates remembered that the rate of the forward and backward reactions is equal in a dynamic equilibrium.
- (ii) Very poorly answered. The vast majority could not competently apply Le Chatelier's principle to the equilibrium provided. Although most could say in which direction the equilibrium moved, they could not explain why. 'When sodium hydroxide is added the concentration of the reactants increases' was a typical answer that gained no marks.
- (b) (i) I This calculation on water of crystallisation was generally well answered and around a half achieved the full marks. The vast majority could work out the mass of the water with few candidates failing to gain any credit.
- II Surprisingly this turned out to be one of the most difficult questions on the whole paper. Most of the answers were too vague e.g. 'heat the solid for a long time' or 'heat until all the water has evaporated' and so did not gain the mark.
- (ii) This question on ionic bonding was very poorly answered. Although a number of candidates recognised that differences in electronegativity were important, many spoiled this answer by saying that 'sodium chloride has stronger van der Waals forces between the molecules'. Others incorrectly stated that sodium iodide was covalent.
- (c) (i) This question on intermolecular bonding was also poorly answered. Although a significant number could identify that iodine monochloride had more/stronger van der Waals forces than chlorine, gaining one mark, a lack of further explanation meant that they did not get the second mark. Many incorrectly compared iodine to chlorine. Most candidates failed to score a mark
- (ii) Well answered but more candidates should have known that  $[\text{ClF}_6]^+$  is octahedral.

- (iii) Although a significant minority were able to correctly calculate the numbers of bonding pairs and lone pairs in the molecular ions, very few could link electron pairs to differences in shapes and so gain all three marks. Some candidates drew or named the correct shapes, but unfortunately did not explain why they were different. Most wrong answers compared the levels of repulsion between bonding and lone pairs rather than the actual number of electron pairs present. Most candidates failed to gain any credit in this question on VSEPR.

### Summary of key points

- If an answer requires a comparison of two compounds/elements a reference must be made to both compounds/elements even if one is negative.
- When answering a question on ionisation energies a reference must be made to 'the outer electron'. Also, 'extra stability due to full outer shell of electrons' is not enough unless qualified.
- Metallic bonding is an array of positive (metal) ions or positive cores surrounded by a sea of delocalised electrons. The metal is held together by the strong forces of attraction between these opposite charges. Both these points are needed to describe metallic bonding.
- The shape of a molecule or ion is governed by the arrangement of the electron pairs around the central atom. Therefore, the most important factor in determining shape is the **total** number of bonding pairs and lone pairs. Comparing the levels of repulsion between lone pairs and bonding pairs is a secondary factor.



# CHEMISTRY

## General Certificate of Education (New)

Summer 2019

### Advanced Subsidiary/Advanced

## UNIT 2 - ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

### General Comments

The paper proved to be accessible in that nearly all questions were attempted by more than 90% of candidates. It also differentiated well in that the success rate varied greatly. It was evident that the vast majority of candidates had prepared for this exam and had learnt much of the specification material so that they were able to score marks in questions that were based on recall. However, to score high marks it was necessary to show understanding of the material and be able to apply knowledge to the specific examples being discussed.

As has been noted in previous reports some responses that needed understanding and application of practical techniques were somewhat disappointing. If, for example, a diagram of apparatus is required it is clearly not necessary to produce a work of art but it should be sufficiently correct as to be of use to a chemist.

### Comments on individual questions/sections

#### Section A

- Q.1** Most formulae were correct and skeletal but a few attached  $\text{CH}_3$  groups were seen.
- Q.2** This was not well answered. Many responses did not start with elements and even those which did often omitted the required state symbols.
- Q.3** This was also not well answered. Precise explanations were required for credit. Some answers that described the 'side of the double bond' did not make it clear whether they were talking about the ends of the double bond or the top and bottom of the molecule as drawn.
- Q.4** Many well expressed correct answers were seen.
- Q.5** Many candidates correctly identified addition polymerisation. It should be noted that 'additional' is not acceptable.
- Q.6** Although some interesting products were seen, many correct responses were given.

## Section B

- Q.7** (a) It was evident that most candidates were familiar with the type of calculations required. Some candidates lost marks for excessive truncation or incorrect rounding.
- Nearly all candidates attempted to compare the amounts present in part (i), to use  $mc\Delta T$  in part (ii) and to divide by the number of moles in part (iii).
- In part (iii) however a significant number however did not divide by the limiting number of moles, as calculated in part (i).
- In part (iv) candidates were generally more successful if they drew the appropriate Hess' cycle although answers using enthalpy changes associated with the relevant equations were accepted if they were clearly explained.
- In part (v) most candidates suggested one method of limiting heat loss but few were able to give an acceptable second change.
- (b) The equation in part (i) was not well done. In part (ii) it appeared that many candidates did not really think through the significance of the apparatus used in the experiment. A large number of diagrams, for example, showed polystyrene cups being heated with a flame!
- (c) (i) Most candidates recognised the need to compare the enthalpy changes associated with bond breaking and bond making. A number however used incorrect numbers of each type of bond, did not include the overall enthalpy change of the reaction or did not divide by 4 in the final stage of the calculation.
- (ii) Candidates who had suggested sensible apparatus in part (b) were able to comment on the need for the substance under investigation being a liquid.
- Q.8** (a) Most candidates recognised that if the concentration is increased the particles are closer together, although some stated that there were more particles present without including that this was within a given volume. To gain both marks it was necessary to state that the collisions were more **frequent** and not merely that there were more collisions. Some weaker candidates erroneously based their answers on the number of collisions with energy greater than the activation energy.
- (b) Since orders of reaction are not part of the AS specification, candidates were required to recognise how the change in concentration affected rate. Part (ii) was generally well answered but fewer candidates quoted the mathematical relationship involved in part (i).
- In part (iii) several methods were appropriate and examples of all of these were seen.
- (iv) Many candidates referred to carbon dioxide and its contribution to the greenhouse effect but fewer mentioned the possible impact of  $\text{NO}_2$ .
- (v) Many candidates also realised that the context of the question and the equation meant that the reaction would occur in the exhaust system. Since a specific knowledge of the catalyst actually used is not on the specification, any transition metal or transition metal compound was accepted.
- (c) Many acceptable answers were seen although a number of candidates drew two curves.

- Q.9** (a) (i) Most candidates stated that the apparatus was set up for reflux.
- (ii) Most candidates also named distillation but many did not state that the separation depended on the ester having a comparatively low boiling temperature.
- (iii) Most gave the correct catalyst.
- (iv) This was not well answered with a significant number of candidates being unable to draw the structure of the acid and alcohol. Very few drew the correct ester and included water in their equation.
- (b) Most candidates gave one correct reagent and the expected observation but only the most able correctly identified which compound(s) gave a positive result.
- Q.10** (a) This is an example where weaker candidates apparently saw the words alkanes and alkenes and, rather than answering the question in terms of bonding and electronegativity, merely wrote all they knew about one or both of these homologous series.
- (b) (i) Since the definition of disproportionation, in terms of simultaneous oxidation and reduction, was given in the stem of the question it was insufficient to say that these both occurred in this equation. To gain credit it was necessary to say the starting material and product of each process.
- (ii) Many correct answers were seen but a significant minority merely calculated the mass of alcohol as a percentage of the mass of the aldehyde used.
- (iii) This was successfully answered only by the most able. Some candidates who realised that sodium would replace the H in OH replaced the one in the alcohol rather than the acid.
- Q.11** (a) All candidates used at least some of the data given and many gave well-reasoned accounts to identify most of the features of the unknown compound.
- (b) Both parts of this question were answered correctly by only the most able candidates. In part (i) many drew lines but did not link the line to the correct carbon in the ester. A number did not choose the correct  $\delta$  value from the data book. In part (ii) very few stated that no useful data was available by considering the heights of the  $^{13}\text{C}$  lines.

### Summary of key points

- Responses should show application of knowledge to the specific context described in the question.
- It is important that candidates avoid seeing a particular word in the question and then merely write all they know about that subject, without reference to the actual question set.
- Candidates should be encouraged to really think about why they are carrying out a practical experiment in a particular way.

# CHEMISTRY

## General Certificate of Education (New)

Summer 2019

Advanced

### UNIT 3 - PHYSICAL AND INORGANIC CHEMISTRY

#### General Comments

This was the third Unit 3 exam for this new specification, and once again there was a small increase in marks compared to previous years. Candidates appear to be becoming more familiar with Assessment Objective 3 style questions (analyse, interpret and evaluate science to make judgements, reach conclusions and develop and refine practical procedures), and so can access higher marks on these. Almost all candidates attempted most question parts, but electrochemistry remains an area that many find challenging and 8% did not attempt the electrochemistry questions. Time did not appear to be a problem with 99.6% of candidates attempting the final part questions.

Many areas of work elicited excellent responses, with many correct calculations and detailed explanations in Section B. Some questions which required factual recall were answered poorly, such as the half-equation for manganate(VII) acting as an oxidising agent. It was disappointing to see three questions in Section A with facility factors around 50% (questions 5, 7 and 8) and especially question 1 where only 40% were able to write an electron configuration for a transition metal ion.

#### Comments on individual questions/sections

##### Section A

- Q.1** This question allowed candidates to apply their understanding of electronic structures in the context of transition metal ions. The example used was not one of the exceptions, however only a minority of candidates were able to write the correct electronic structure. This question had the lowest facility factor of any in Section A. Common errors included the electronic structure of Co ( $3d^7 4s^2$ ), losing 3d electrons before 4s ( $3d^5 4s^2$ ) and identifying the d-subshell as 4d.
- Q.2** Almost all candidates gained marks on this question and it was pleasing to see many able to draw the dot-and-cross diagram of ammonia and to distinguish between covalent and co-ordinate bonds. A few candidates drew the coordinate bond as a pair of crosses which suggested that these electrons were a lone pair from Al.
- Q.3** It was pleasing to see so many candidates were able to recall this expression correctly with over three-quarters gaining the mark.
- Q.4** The metal was identified as platinum by almost all candidates although a very small number suggested iron or even potassium. Most recalled that platinum was inert although a few thought the metal was used solely as a catalyst. One candidate thought that platinum was 'inane' and another considered the metal to be 'insane'! Despite this, nearly 80% of candidates gained this mark.

- Q.5** This question led to mixed answers. Some candidates incorrectly attributed the difference to the inert pair effect. Most realised that the difference was linked to the d-orbitals in the valence shell of silicon and not of carbon, but the quality of the answers varied significantly. Many referred to one of the two compounds and not the other. Only about half the candidates gained the marks here.
- Q.6** Most candidates realised that the entropy of a gas was much higher than that of a liquid and gained the mark.
- Q.7** (a) Many answers here did not give the correct formulae for the oxide of iron, with  $\text{Fe}_2\text{O}_3$  being seen in many answers. Other answers lacked the correct stoichiometry of reagents. Some candidates incorrectly gave  $\text{Fe}_3$ ,  $\text{Fe}_2$  or  $\text{FeO}$  as products. This contributed to a facility factor of 47% for question 7.
- (b) Most answers referred to both elements and the best answers applied the inert pair effect well. Weaker answers referred to one of the two elements only or used the term inert pair effect but did not apply this to the compounds present.
- Q.8** This question was poorly answered. Some candidates gave complexes containing water ligands, suggesting they did not read the requirements of the question. Candidates that did know the complex that was required did not always show this in three dimensions or did not clearly indicate charges. Just over half the candidates gave the correct structure.

## Section B

- Q.9** (a) (i) Most candidates failed to gain this mark with  $242 \text{ kJ mol}^{-1}$  being the most common incorrect answer.
- (ii) This question was answered well by most candidates. They could apply the ideas of Born-Haber cycles appropriately and most who reached a different answer gained some credit for their working.
- (iii) This question required candidates to combine ideas from their energetics studies and their ideas of successive ionisation energies. It was pleasing to see that so many candidates were able to do this to suggest an appropriate value. A few candidates thought that  $1735 \text{ kJ mol}^{-1}$  was the first ionisation energy and then applied the trends in ionisation energies to suggest a value above this. Few candidates suggested that the answer would be half of  $1735 \text{ kJ mol}^{-1}$ .
- (b) Part (b) as a whole had the best marks in Section B. Over 70% of the marks were awarded reflecting once again the ability of candidates to undertake familiar calculations competently.
- (i) Most candidates were able to calculate the entropy change correctly. A minority did not include the factor to change from  $\text{kJ mol}^{-1}$  to  $\text{J mol}^{-1}$  and obtained an answer 1000 times too small.
- (ii) This question was well answered by almost all candidates. Very few obtained any answer other than 4.
- (iii) Almost all candidates knew the flame colour for calcium. A small number gave 'red' without any other detail and this was not awarded a mark. The colours red, brick-red and crimson are all associated with different s-block metal flame tests.

- (c) The observations with both halides were recalled well by most candidates, although poorer answers included some vague descriptions e.g. 'both reactions give fumes' and 'with bromide the solution changes colour'. The explanations were often of a lower standard and candidates did not distinguish between bromine and bromide, with some stating that 'bromine is a reducing agent' rather than bromide.
- Q.10** (a) (i) Candidates were able to apply some of the information provided to produce a rate equation, with most showing this as first order with respect to iodomethane. Fewer used the units of the rate constant to note the overall rate equation was second order and hence gain both marks.
- (ii) The Arrhenius equation includes some of the most challenging mathematical work in the unit. Despite this, questions involving this equation are generally answered well. Rearranging to produce an expression for  $T$  is possibly the most challenging rearrangement, however it was pleasing to see so many performing this correctly and expressing their answer in a variety of ways, with  $k$  and  $A$  included as  $-\ln(k/A)$ ,  $\ln(A/k)$  and  $\ln(A) - \ln(k)$ . The most common mathematical error was to write  $\ln(A - k)$  in place of  $\ln(A) - \ln(k)$ . Another error seen frequently was a failure to convert kJ to J. This led to an answer of 0.3 K and it was disappointing to see that some candidates considered this to be a reasonable temperature for the reaction.
- (b) Most candidates performed well on this part question, with the facility factor of 66% being amongst the highest in Section B.
- (i) This was a straightforward question and marks reflected the ability of candidates to recall the meaning of the term. Many candidates took time to explain the ideas of sampling as well, despite this not being part of the question. This was not penalised, nor did it gain additional marks.
- (ii) Starch was the answer seen in the vast majority of responses. A few candidates assumed it must be an acid-base indicator and suggested phenolphthalein or methyl orange.
- (iii) This is a well-known observation and the vast majority of candidates gained this mark.
- (c) Most candidates scored good marks on this part question, with the facility factor being the second highest in Section B.
- (i) I. The meaning of a *homogeneous* catalyst was recalled well by most. A very small number defined a heterogeneous catalyst.
- II. The answers here frequently gave an answer appropriate for a heterogeneous catalyst, with discussion of adsorption on a metal surface. Despite this most gained some credit for ideas of activation of molecules by oxidation or reduction.
- (ii) This question was well answered with most candidates gaining both marks. A few omitted the square root and were awarded 2 marks for a pH of 5.4.

- Q.11** (a) (i) A significant number of candidates could not recall the half-equation for manganate(VII) acting as an oxidising agent. Where candidates gave a balanced half-equation for this process, even if it was incorrect, they were able to gain a mark for using this half-equation to produce a full equation.
- (ii) I. Most calculated the mean volume correctly, knowing which values to include and which to ignore.  
II. Many candidates correctly calculated the concentration of the solution used in the titration. Numerous answers were accepted as they followed from errors in earlier part questions. Fewer candidates included the initial dilution factor and so answers of  $0.160 \text{ mol dm}^{-3}$  were more common than  $1.60 \text{ mol dm}^{-3}$ .
- (b) This QER question tested a range of ideas on acids, bases and indicators. As part of their course candidates are expected to familiarise themselves with a range of titrations, including the use of different indicators and pH probes and this aids them in both the practical assessments and the written papers. The question required three elements in a full answer: identification of methods that would work, explanation of why some methods work and a discussion of the shape of the curve. Most candidates gained some marks on this question but only a few answers were awarded 5 or 6 marks.

Identification of the methods that would work was the strongest element of many answers. The best answers referred to all four methods and identified the three that would work and the one that would not. Some answers did not refer to all the methods which limited the credit awarded. A few candidates focused on comparing methods (e.g. 'Brychan's method was better than David's because it lies on the larger vertical region', 'Alice's method is weaker than David's because pH probes measure to fewer significant figures than titration methods'). As the question does not ask candidates to compare methods these answers were treated as neutral and examiners focused on whether candidates indicated methods as ones that would work and ones which would not.

The explanations of why methods worked was poorer. Often the best answers were succinct, stating that indicators with pH changes within the vertical regions worked and those that were not within vertical regions did not. Some expressed themselves poorly referring to the straight regions or saying that indicators 'matched' the vertical regions without reference to the indicator's pH range. A few thought that no indicator would work as they did not lie in both vertical regions. Very few candidates referred to how the pH probe data could be used to find the volume of NaOH at either equivalence point. Some thought they could use the pH after adding  $15 \text{ cm}^3$  to find  $K_a$  and use this to find the concentration.

There were many elements that could have been discussed regarding the shape of the curve and most appeared in answers provided by candidates. The most common correct elements were the linking of the two vertical regions to the two acidic protons in oxalic acid and the differences in their pH values reflecting different acid strengths of the two protons. References to buffer regions in appropriate locations were given credit although it was disappointing to see some candidates linking this to the pH at  $15 \text{ cm}^3$  which showed a clear lack of understanding.

- Q.12** (a) (i) Most candidates answered this well, giving complete and detailed answers.
- (ii) This part question showed an improvement over similar questions in the past. Most understood that nitric acid was an appropriate acid, although a few suggested ethanoic acid which was also accepted. The reason for using this acid was less well known, with weaker candidates suggesting that other acids might 'interfere with step 2' or that hydrochloric acid was too strong or too weak. Only stronger candidates realised that insoluble lead chloride would be formed.
- (iii) This was well answered by many. Some could not recall the colours of the precipitates and a very few even suggested there were no precipitates, despite what the question said!
- (iv) Most understood that additional sodium hydroxide would cause the precipitates from amphoteric metals to dissolve. Some candidates did not make a comparison i.e. they stated that the precipitate formed from lead dissolved without reference to the magnesium precipitate being insoluble.
- (b) These calculations were poorly done. The mean mark for both parts was 1.9 out of 6 with most of these marks obtained in part (i). The ratio of Mg:Ca was calculated well in many cases, however only a minority of candidates balanced these cations with an appropriate number of carbonate anions. In the second part, very few candidates gained all three marks. Many calculated the number of moles in 220  $\mu\text{g}$  of huntite but few could use the concentrations given in the stem to calculate a volume. Questions on concentrations that ask candidates to calculate moles and concentrations are more common in past papers, and it may be that candidates were not as familiar with calculating volume in a similar manner.

- Q.13** (a) This was the most poorly answered part-question on the paper. The use of electrochemical potentials to determine feasibility is frequently a challenge for candidates, especially where more than one oxidation or reduction can occur sequentially. This is usually a good area to differentiate between candidates at the highest grades.

The most common area where candidates gained marks was on identifying the main product of the reaction in the absence of oxygen (Elfed's experiment). Fewer identified that in the presence of oxygen,  $\text{Cr}^{2+}$  would be oxidised back to  $\text{Cr}^{3+}$ . Many candidates thought that  $\text{Cr}(\text{s})$  would be formed in one or both of the reactions. The explanations were often poor and showed a lack of understanding of the meaning and use of standard electrode potentials.

- (b) (i) Most could write the expression for  $K_c$  and gained this mark.
- (ii) Most realised that they needed to use the  $M_r$  of water to calculate the moles in 1000g. A few tried to use the expression for  $K_c$  and lost the marks.



- (iii) There were several approaches possible in this question and most candidates that scored good marks rearranged the  $K_c$  expression to find  $[H^+]$  then used this to find pH. Most then stated that the pH was acidic so the student was incorrect. Some simply stated the pH was 5.8 so the student was incorrect and gave no further detail. This was not sufficient to gain full marks. A few candidates used their knowledge of  $K_w$  to state that  $[H^+] = 1 \times 10^{-7}$  in a neutral solution and compared this to  $[H^+]$  calculated from the  $K_c$  expression. This was an acceptable alternative approach. A very small number included  $1 \times 10^{-7}$  in the  $K_c$  expression and showed that the value of  $\frac{[chromate]^2}{dichromate}$  does not equal 0.057. This was also acceptable.
- (v) This was well answered by most. There were many cases of answers that contradicted themselves here e.g. 'the reaction was endothermic and the enthalpy change was negative' or 'the reaction shifted to the left as there was an increase in products'. This may have been candidates rushing at the end of the paper, but nonetheless almost all candidates attempted this part.

### Summary of key points

- Questions which require comparisons are common in Unit 3 papers, and in many cases candidates are not explicit enough in their responses. Answers which refer to one of the elements/compounds/reactions in question and fail to mention the other are unlikely to gain credit. Examples of this were seen in questions 5, 7(a) and 12(a)(iv).
- Candidates need to be familiar with questions using many SI prefixes in their units, as well as common non-SI units, such as atm or °C. Questions requiring candidates to interconvert units challenge many candidates and caused problems in question 9(b)(i) (kJ to J, °C to K) and 10(a)(ii) (kJ to J). Candidates should familiarise themselves with questions where the units are always interconverted, such as enthalpy and entropy or the ideal gas equation, and ones which may require interconversion such as the use of atm and °C.
- Naming halogens and halides causes problems for many candidates. It is not acceptable to use bromine and bromide interchangeably. In question 9(c) it was not uncommon to see candidates stating that 'bromine is a reducing agent' or 'bromide is an oxidising agent'. It is important that candidates are aware that incorrectly naming any species may negate their answers.

# CHEMISTRY

## General Certificate of Education (New)

Summer 2019

Advanced

### UNIT 4 - ORGANIC CHEMISTRY AND ANALYSIS

#### General Comments

The examiners felt that candidates are becoming more accustomed to the new style of this paper with its greater emphasis on the application of learnt material rather than straightforward recall. This 80-mark paper was designed to take one and three-quarter hours and there was little evidence of candidates being rushed to complete it in the given time. The majority attempted every question. The QER question proved to be a good discriminator and showed a wide variety in the quality of responses and in the marks obtained. Calculation questions were generally answered well but converting between units (especially those of length and volume) continues to bother a number of candidates. Questions that carried more marks and required a greater depth of detail were sometimes poorly explained and lost candidates a number of easier marks. As in the past, questions where candidates were required to call upon their knowledge of practical work and techniques were not answered as well as might have been expected.

In general the examiners found that the paper had worked well. It provided candidates with an opportunity to show what they had learnt and understood during the course and to apply their knowledge in unfamiliar situations.

#### Comments on individual questions/sections

##### Section A

- Q.1** This was meant to be an easy first mark but a number of candidates could not use the skeletal formula of TATP to obtain its molecular formula. Some gave the empirical formula of the compound, which was not required.
- Q.2** This was a question about a decarboxylation reaction and some candidates gave propanoic acid as their answer, forgetting that in this type of reaction the carbon chain loses a carbon atom.
- Q.3** Although many candidates correctly worked out the relative peak area correctly, quite a few lost the second mark by referring to the protons labelled 'b' as a doublet, although they are both in the same environment. The splitting mark could be obtained by using several different terms, phrases or words.
- Q.4** The majority of candidates gained this mark. Those who drew the structures rather than the letters also received credit.
- Q.5** A number of scripts were seen where candidates provided weakly worded explanations on why spot **C** was alanine. There was sometimes confusion between 'highest', 'largest' and 'furthest'.

- Q.6** Knowledge of the 'triiodomethane test' often gained both marks for many candidates. Some papers were seen where the reagent used was 'iodoform' . This gained no credit but if the correct result was given then the second mark was awarded. A number of candidates chose inappropriate tests and gained no marks.
- Q.7** (a) This was well answered with candidates selecting a variety of possible answers.
- (b) This was less well answered. Candidates could write both chlorine atoms 'up' or both 'down'. Some did not realise that a stereoisomer of the drawn 1,2-dichlorocyclopropane was required and gave a straight chain isomer, thereby losing the mark.
- Q.8** (a) (i) This question was not well answered and relatively few gave the required  $\bullet\text{CH}_2\text{COOH}$ . The commonest wrong answer was  $\text{CH}_3\text{COO}\bullet$ .
- (ii) The calculation for both parts I and II were generally well done with many candidates gaining full credit in both parts. Sometimes a mark was lost in part II for not providing an answer to three significant figures. In part III some scripts were seen where the zwitterion/ ionic nature of aminoethanoic acid was not given. Relatively few candidates could explain that ionic compounds are not soluble in organic solvents like methanol.
- (b) Almost every candidate knew why an aqueous solution of aminoethanoic acid did not affect the plane of plane polarised light.
- (c) Most candidates could provide the dipeptide produced from aminoethanoic acid.
- (d) Most scored good marks for this question, usually at least 2 out of 3. Sometimes the final mark was lost for an incorrect or missing volume conversion.
- (e) The majority of candidates realised that the sodium salt of the acid would be formed and that acidification was necessary to produce the acid itself.
- Q.9** (a) (i) Many candidates found it difficult to explain their answers clearly although it was obvious what they were trying to write. Some wrote that there are 'even' or the 'same' number of carbon atoms each side of the double bond but this was not enough to be awarded the mark.
- (ii) The colour of the DNP derivative was well known and yellow, orange and red were popular acceptable choices.
- (iii) I. Many candidates correctly wrote that the compound could not be an aldehyde.
- II. A number of candidates scored at least 2 marks out of 3. Some candidates did not clearly indicate whether the change in the melting temperature of the impure compound was an increase or a decrease on that of the pure material.

- (iv) This was poorly answered by many candidates who could not link the information given back to the starting alkene.
- (b) There were a number of possible answers to parts (i) and (ii) and sensible suggestions gained credit in both.
- (iii) Although many candidates could name the piece of apparatus as a separating funnel, many of the sketches did not show this item. Burettes and diagrams of distillation apparatus were commonly seen.
  - (iv) This question asked candidates to complete the mechanism for the nucleophilic addition reaction of propanal with hydrogen cyanide. A lot of detail was needed here and good answers were not common.
- Q.10** (a) (i) The reagents necessary for this diazotisation were well known.
- (ii) Although the formula of the required amine, N,N-dimethylphenylamine was often given correctly, a number of candidates drew N,N-dimethylphenylamine with another  $\text{—NH}_2$  group at the 4-position, not realising that the azo group came from the diazo-compound used.
- (iii) The calculation was often correct. Common errors were not recalling the  $f = c/\lambda$  equation correctly and not converting nanometres to metres.
- (b) The calculations in parts (i) and (ii) were very well done with many candidates gaining all four marks.
- (c) (i) A number of good answers were seen in this question. It was essential to show an unambiguous formula for ethanamide.
- (ii) The examiners thought that it was important to emphasise that it is the nitrogen atom that has the lone pair which enables the amide to act as a base. Those who wrote that it was the  $\text{—NH}_2$  group did not gain the mark.
- (iii) It was important in this question to write what happened to the intensity of the characteristic peaks **during** the reaction. Too many just quoted that the C=O bond was present in the amide and the C $\equiv$ N bond in the nitrile (and their absorption values).
- (iv) It was important for candidates to read this question carefully. Sometimes it was apparent that this had not been done. Better responses commented on the greater strength of the aromatic C—Cl bond compared with the aliphatic C—Cl bond.

- Q.11** (a) (i) The quality of extended response (QER) was assessed in this question. It proved to be a good discriminator with a wide range of answers being seen. Most candidates recognised the importance of the health and safety aspects of the experiment i.e. use of a fume cupboard. Many did not select appropriate containers in which to carry out the experiment (or state their volumes) although the question clearly asked for these details.
- (ii) This calculation was well done with many candidates gaining all 3 marks.
- (iii) The information given pointed candidates towards deducing that compound **J** was a 2-hydroxybenzenecarboxylic acid containing two nitro-groups rather than one, but a number of candidates did not use the information correctly.
- (iv) The whole point of using dilute nitric acid at lower temperatures in this preparation is to try and prevent polynitration of the acid. Too many candidates thought that the yield of the required acid would be increased by using stronger nitric acid, increasing the temperature or increasing the reaction time, when in fact the reverse is required.
- (b) Nearly all candidates correctly stated that the acid would effervesce with a carbonate whereas the aldehyde would have no reaction.
- Q.12** (a) (i) Nearly all candidates could identify the ester group that was present in the formula of polyester **P** provided.
- (ii) The alkaline hydrolysis of the polyester will give the sodium salt of the acid. Many candidates did not realise this and lost the marks.
- (iii) Many candidates could offer some suggestion as to the differences between the two types of polymerisation e.g. condensation polymerisation results in loss of a small molecule but addition polymerisation does not.
- (iv) Most scored 2 marks in this question by identifying the aromatic and aliphatic carbon peaks. Fewer candidates identified that five environments exist.
- (v) Nearly all candidates scored 1 mark for the aromatic dialdehyde but this was not often supported by valid reasoning and it was uncommon to award more than 3 marks.
- (b) (i) Although many candidates gained the mark for the use of  $\text{PCl}_3$ ,  $\text{PCl}_5$  or  $\text{SOCl}_2$ , a number suggested  $\text{HCl}$  or even  $\text{NaCl}$ .
- (ii) The correct answer was 94%. Some candidates made arithmetic errors early in the calculation and only gained a single mark.
- (iii) Most candidates realised that hydrolysis had occurred due to water ingress or from moisture present in the air. Some lost the mark by describing that oxidation had occurred or that the acid was present as an impurity.

### **Summary of key points**

- The questions, especially those involving application, need to be read very carefully
- All chemical equations must be balanced
- Excessive truncation should not be used part way through calculations carrying several marks
- In QER questions, read the question carefully and try to identify the key points required
- Pay attention to detail in questions about practical procedures

**CHEMISTRY**  
**General Certificate of Education (New)**  
**Summer 2019**  
**Advanced**  
**UNIT 5a - EXPERIMENTAL TASK**

**General Comments**

All candidates scored over 10 marks out of a possible 30. All were capable of collecting their own data in both parts of the experiment.

In addition, candidates could mostly record their results in an appropriate and acceptable way even though some dropped careless marks for neglecting basic aspects such as the correct units or the required number of decimal places.

Graphical work was less well done. The second graph proved more challenging than the first. Manipulation of data, e.g. calculating rate from time, finding the concentration of diluted peroxide solutions and changing temperature from °C to kelvins, was often disappointing.

The last three questions required an application of theoretical ideas to a practical context and were only well done by the strongest candidates.

**Comments on individual questions/sections**

**Recording of Results**

**Parts A & B**

The two tables illustrating the results of both rate experiments were very well constructed overall, with the majority of candidates gaining at least 6 out of a possible 8 marks. Common errors included:

- missing units
- recording time to 2 decimal places when this is meaningless
- omitting the result from Part A in the table for Part B

Generally, most candidates' results followed a similar pattern to those provided by the teacher. All candidates managed to obtain a useable set of results to use in the analysis section.

**Analysis of Results**

(i) Most candidates were comfortable with the calculations of both hydrogen peroxide concentration and the rate of reaction and managed to get both marks. Some lost marks for:

- careless errors in calculating rate
- excessive truncation of rate values
- failing to calculate the concentration of peroxide solutions

Those that could not correctly calculate the concentration of peroxide could still access the marks for the graph and the order of reaction in parts (ii) and (iii).

(ii) The graph of rate against concentration produced full marks for most, including those who had incorrectly calculated concentration values. However, careless marks were dropped for:

- inconsistent/inappropriate scales
- joining the plotted points rather than drawing a best-fit line
- trying to pass the line through the origin and hence ignoring most points

(iii) Most managed to work out that the reaction is first order with respect to peroxide but many struggled to explain their reasoning clearly enough. They needed to convey the idea that rate and concentration were directly proportional.

(iv) The table for Part B was very well done. Many scored 4 marks. Marks were usually lost for:

- careless arithmetic in the calculation of temperature in kelvins
- excessive truncation or incorrect rounding
- incorrectly recording calculator values

Those that could not correctly complete the table could still access the marks for the graph and further questions in parts (v)-(viii).

(v) The graph was well done and most candidates were able to work out a gradient and subsequently calculate an activation energy. Candidates who had reactions times of around 7 seconds or less had to remove the  $-2.0$  value from the top of the y-axis on their graph in order to plot the highest  $\ln(\text{rate})$  value or omit that point from their graph. This caused little difficulty for candidates or for examiners.

(vi) Although quite a few candidates managed to score both marks here, most scored just 1. Some were unable to convert their value to  $\text{kJ mol}^{-1}$  and others lost a mark for giving an activation energy with a negative sign.

(vii) This question was not well answered. Some gave a rate equation instead of a chemical equation for the rate determining step. Some left out the peroxide or included the acid.

(viii) Most candidates scored 1 mark here for recognising that a different sample would be too fast at higher temperatures. Very few linked higher concentrations AND higher temperatures, explaining that this would provide a time too fast to be considered accurate. Many gained no marks as they wrote a detailed account of the particle theory and how temperature affects the rate of reaction.

### Summary of key points

- Candidates need to ensure that they can calculate the concentration of a solution when it is diluted. Many recorded increased concentrations for solutions which had been diluted.
- Constructing scales on graphs, especially a negative scale, appears to be a problem for quite a lot of candidates and this skill needs to be further developed.
- Mathematical skills need further development with many candidates losing easy marks for simple manipulation such as finding a reciprocal or the natural log of a value. Candidates should be encouraged to give such values to 3 significant figures as a rule of thumb.



# CHEMISTRY

## General Certificate of Education (New)

Summer 2019

Advanced

### UNIT 5b - PRACTICAL METHODS AND ANALYSIS TASK

#### General Comments

This was the third examination of this unit and 2147 candidates sat the paper. The paper proved successful again this year in that it differentiated well. Some marks were accessible to almost all candidates whilst others were gained only by the most able. This led to a good distribution of marks with all available marks being scored by the most able candidates. The mean mark was 13.4 out of 30, slightly down from the mean mark of 15.7 in 2018.

The most successfully answered question as a whole was question 1 with a facility factor of 48.2%. The least successfully answered question was question 3 with a facility factor of 40.1%. Most candidates attempted all parts of the paper and there was no evidence that lack of time was a factor in performance.

#### Comments on individual questions/sections

- Q.1**
- (a) Poorly answered on the whole with very few candidates correctly recognising that cooling was required to prevent substitution of further nitro- groups. The most common incorrect answers were 'to prevent further reaction', 'the reaction is very exothermic' and 'to slow down the reaction'.
- (b) There were many good answers detailing a safe procedure to recrystallise the product. To gain full marks the answer had to include reference to dissolving the solid in the **minimum** volume of **hot** ethanol and the correct sequence of steps was essential.  
Surprisingly, there were also many very poor answers to this question with some candidates trying to distill off the ethanol and others washing the recrystallised compound with hot ethanol.
- (c) Using the given data, the majority of candidates managed to correctly calculate the mass of methyl benzenecarboxylate used in the experiment as 5.40 g. Then, far too many candidates incorrectly calculated the percentage yield based on the masses.
- $$\frac{4.56}{5.40} \times 100$$
- These candidates scored only 1 mark out of 4.
- (d) This question required candidates to distinguish between three isomers of  $C_8H_7NO_4$  using chemical tests / reagents of their choice and give the linked observations for the positive tests. It clearly differentiated between those who had thoroughly revised the organic functional group tests and those who had not. It was surprising to see that some A2 candidates were unable to score any marks for this question.

In part (i), the isomer to be identified had both a carboxylic acid and aromatic amine functional group. The carboxylic acid group could be identified of course using sodium carbonate / sodium hydrogencarbonate but 'addition of HCl / effervescence' was often seen. Identifying the aromatic amine group proved to be more challenging and only a very few candidates correctly described the reaction with nitric(III) acid (or nitric(III) acid and naphthalene-2-ol) and gave the linked observation.

In part (ii), the isomer to be identified had a methyl ketone group and a phenolic —OH. All too often, the weaker candidates incorrectly chose Tollens' reagent or Fehling's solution. Even when 2,4-DNPH was correctly identified as a suitable reagent, the incorrect observation was often given. Where candidates chose 'iodoform' as a reagent this did not gain credit. Similarly, candidates recognised the need to identify the phenolic —OH group, but incomplete and imprecise observations such as 'brown to colourless with bromine solution' and purple precipitate with FeCl<sub>3</sub> solution did not gain credit.

**Q.2** This question clearly differentiated between candidates that had a thorough understanding of the fundamentals of inorganic chemistry and those that had not. Two of the available marks were awarded for a suitable plan that would allow the identification of all four species, whilst a suitable plan that would allow the identification of two or three of the species gained 1 mark.

Some excellent answers were seen to this 8-mark question. These candidates worked logically, devised a plan that would correctly identify all four of the unlabelled solutions and included ionic equations for the reactions they planned. They scored 7 or 8 marks.

However, it was surprising to see that a number of A2 candidates were unable to score any marks for this question. Some candidates were unable to identify the iodide ion using AgNO<sub>3</sub>(aq). When the iodide ion was correctly identified, many were unable to write an ionic equation for the reaction. No credit was given for answers where iodine/iodide and chlorine/chloride were used incorrectly.

Similarly, a number of candidates were unable to identify the carbonate ion using dilute sulfuric acid and the ionic equation for this reaction proved difficult for many candidates.

Only the most able candidates devised a plan that allowed them to identify the chlorine solution (by addition of aqueous iodide) and the thiosulfate solution (by addition of aqueous iodine formed previously in the Cl<sub>2</sub>(aq) / I<sup>-</sup>(aq) reaction).

- Q.3** (a) This question has been asked previously and was well answered by the vast majority of candidates.
- (b) Part (i) of this question was written to facilitate access to the double titration calculation. However, only a small number of candidates were able to explain why the difference between  $V_2$  and  $V_1$  represented the volume of acid reacting with the original sodium hydrogencarbonate.

In part (ii), where candidates were asked to calculate the percentage by mass of sodium hydrogencarbonate in the original solid mixture, the most common error seen was in scaling up from  $25 \text{ cm}^3$  to  $500 \text{ cm}^3$ , with many candidates scaling up to  $250 \text{ cm}^3$ . Another common error was using the  $M_r$  of sodium carbonate rather than the  $M_r$  of sodium hydrogencarbonate in the calculation.

- (c) This second method using gas collection should have given the same percentage by mass of sodium hydrogencarbonate in the solid mixture as method 1. Answers here were disappointing and only the most able were awarded the full 4 marks.

In part (i) the weaker candidates calculated the volume of carbon dioxide produced by simply taking 62.3% of the total  $99.7 \text{ cm}^3$  of carbon dioxide. Candidates should be aware that such a basic calculation would not be awarded 2 marks and that it may therefore not be the correct one! The most able candidates understood that the mixture contained 62.3% of sodium carbonate by mass in the mixture, and thus correctly calculated the mass and moles of sodium carbonate in  $25 \text{ cm}^3$  of the solution. They then used the molar gas volume to calculate the volume of carbon dioxide released in the reaction between the sodium carbonate and the hydrochloric acid. A few candidates used  $pV = nRT$  to calculate the volume of carbon dioxide but this is rather a laborious method.

In part (ii), the candidates had to subtract the volume of carbon dioxide calculated in part (i) from the total carbon dioxide volume collected, calculate the number of moles of carbon dioxide present (again using the molar gas volume) and hence the number of moles of sodium hydrogencarbonate. The percentage of sodium hydrogencarbonate present in the mixture comes out as 29.1% as it does in (b)(ii). Only a small minority of candidates were able to follow logically through all the steps in the calculation.

### Summary of key points

- As noted in last year's report, more marks are lost for shortcomings in basic recall than in dealing with data given in new situations. Recall of organic functional group tests and the linked observations is essential.
- Similarly, candidates should be able to recall how to test for the inorganic ions listed in the specification, describe the linked observations and be able to write ionic equations for the reactions taking place.
- Candidates are once again advised to read the questions carefully. Too many lost a mark in question 3(b) by incorrectly scaling up from  $25 \text{ cm}^3$  to  $250 \text{ cm}^3$ .
- Calculations that were slightly different e.g. question 3(c) were poorly done showing that some candidates' understanding of numerical concepts is lacking in depth.



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