

CCEA GCE - Chemistry  
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## Chief Examiner's Report

chemistry



## Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Chemistry for this series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at [www.ccea.org.uk](http://www.ccea.org.uk)



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## GCE CHEMISTRY

### Chief Examiner's Report

#### Assessment Unit AS 1 Basic Concepts in Physical and Inorganic Chemistry

- Q11** It might have been imagined that this question would have proved to be relatively easy for candidates and it was but there was a significant minority who made mistakes. The errors were made with the ionic/covalent nature of the silver halides when it was said that silver bromide and iodide were covalent. In very few cases all the silver halides were said to be covalent. Less frequent was to obtain an incorrect solubility for silver bromide or silver iodide.
- Q12**
- (a) The oxidation numbers of the elements were not well deduced compared to previous examinations. The most frequently misinterpreted oxidation number was that of oxygen which was written as  $-6$  ( $3x-2$ ) and  $-4$  ( $2x-2$ ). Perhaps even more surprising was to see potassium regularly written as  $+7$ . Oxidation number questions have been frequently asked and very well answered in the past. Candidates had little difficulty in transferring their incorrect answers into a suitable explanation of why the reaction was a redox reaction.
- (b)
- (i) The questions asked in this part of the paper were directly from the specification but had very limited success. Many implausible formulae were presented for the reaction of chlorine with potassium hydroxide. They included hydrogen and potassium.
- (ii) The question asked for conditions and more than one was expected but most answers gave only one which was usually heat. Such was the lack of knowledge shown that answers included fume cupboard and catalysts including platinum. A very small number of candidates obtained the correctly balanced equation.
- (c)
- (i) The formula of phosphorus trisulfide was correctly stated by the vast majority of candidates.
- (ii) Candidates appeared to appreciate whether phosphorus trisulfide was ionic or covalent but were often let down by their expressions of the answer. Examiners can only mark what is seen. An answer such as, "covalent due to being non-metals forming simple molecular structures" did not mention elements being non-metals nor anything else. It was essential to mention that it was the elements which were non-metals or to state e.g. "covalent, the bonding is between *two* non-metals". Admittedly there is an issue here about what is meant by the term "non-metal". Other candidates mentioned the difference in electronegativities and if correctly expressed the mark was awarded.
- (iii) It will not come as a surprise to teachers or those who prepare candidates for examinations that this question was not answered as well as expected. No answer was seen which said that phosphorus trisulfide oxide was formed but there were still many answers which fell well short of the correct answers. Some answers said that phosphorus and sulfur were formed, others said phosphorus dioxide and sulfur monoxide. But what was surprising was the mention of

silicon(IV) oxide even though  $\text{SO}_2$  had been written. Why carbon dioxide and fluorine were thought of was surprising. This relatively simple question should have been better answered. Despite the poor attempts at this particular question the overall performance on the paper was very good.

- (d) (i) The formula of the ammonium ion was accurately written by all candidates.
- (ii) The name, the shape and the bond of the ammonium ion were well described. Quite a few times the dative covalent bond from the nitrogen atom to a hydrogen atom was given in the shape of the ammonium ion but it was not penalised.
- (iii) The formula of ammonium phosphate was often given as  $\text{PO}_4(\text{NH}_4)_3$  which was just as correct as  $(\text{NH}_4)_3\text{PO}_4$  although a little unusual at first.
- (iv) The response to this question which required the presentation and explanation of three physical properties of ammonium phosphate was poor. Although many candidates obtained a mark there were very few that obtained the maximum of three marks. The specification mentions melting point, boiling point, solubility and conductivity.

With regards to conductivity, candidates had to state that ammonium phosphate conducted when molten or aqueous. Most candidates stated only when molten which was a partial explanation. There were also many answers that mentioned delocalised electrons which was quite irrelevant for an ionic compound. Some candidates wished to mention that ammonium phosphate had a lattice structure which was difficult to break and furthermore there were covalent bonds between the ions. Others said that ammonium phosphate was soluble in water because of the formation of hydrogen bonds.

- Q13 (a) Despite the introduction to the question which heavily emphasised that francium was found in period 7 of the Periodic Table and that it was an s-block element, many candidates wished to say that francium had an s-subshell. However, there was a minority that stated the answer to be  $7s^1$  and obtained the mark available.
- (b) (i) The relative atomic mass of a neutron was known by all candidates.
- (ii) Although some could argue that this was a question formerly asked it was still specification specific and virtually all candidates obtained the correct answer. There were a very small number of candidates that tried to use the equation to prove that the mass of the neutron had a value of one and might have gained one mark if their calculation was correctly set out.
- (iii) All candidates realised that electrons had minimal mass and thus deduced that they had no influence on balancing the equation according to mass.



- (c) (i) The meaning of the term electronegativity was well answered. Candidates are now very familiar with the advised list of definitions and are able to reproduce the definition supplied. Despite this there are still some variations that were seen. For example, the supplied definition states that an atom attracts the electrons in a covalent bond. Using the word element instead of atom loses a mark. Of course, in learning a definition candidates can get “mixed up” and a few candidates said “the extent to which atoms are attracted to bonding electrons in a covalent bond”.
- (ii) There was no need to state an explanation for the answer to this question but many candidates did so. The word “increase” obtained the mark but many went on to say that “electronegativity values increase on going across a period”.
- (d) (i) The explanation for the low melting point of francium was often weak and often difficult to interpret because many correct things were said but they often contradicted or were not sufficiently accurate. For example it was said that there were weak electrostatic charges between the atoms. It was said that there was more electron shielding. There was mention of low charge density which might have meant that seeing as the charge was  $1+$  the volume was greater therefore the radius of the ion was greater. This was a lot to take in when the essential point was that the radius of the ion was greater. However, depending on the greater context of an answer it was acceptable. There were many answers which caused a second reading e.g. “there are more positive cations and delocalised electrons meaning lower down the group there is a greater charge density and the bonds require less energy to break.” The slight ambiguity did not help i.e. “more positive”.
- (ii) The greatest misconception was to think that caesium had the most delocalised electrons. All the Group I metals have one delocalised electron per atom. It was extremely surprising that this idea had such a common hold on the candidates. The only explanation thought of was that candidates were confusing previous questions, possibly, which compared different metals from different groups. However the second part of the question usually gained a mark i.e. the electrons moved and carried charge. This has been a standard answer for many years for the conduction of electricity.
- (e) (i) The equation for the loss of an electron from a francium atom was often given with state symbols which were not required but it was usually correct.
- (ii) What was surprising was to see the equation  $\text{Cl}_2 \rightarrow 2\text{Cl}$  so regularly given. But the correct equation was the most common answer.
- (iii) The previous questions given in Part (e) appeared to drive candidates to offer equations with ions in this particular question i.e. the formula of francium chloride was frequently given as  $\text{Fr}^+$  plus  $\text{Cl}$ . Provided the equation was balanced it was accepted. Occasionally the equation was not balanced and there was use of  $\text{F}^+$  rather than  $\text{Fr}^+$ . Candidates normally secured the mark available.

- (iv) There were often long and convoluted answers to this question. Seeing as only one word was essential to the answer much of these responses were irrelevant to the question asked. This was the first time that this question was asked. The specification, of course, mentions this word but not the definition or the description. With questions of this nature there is the dilemma of either giving a specific answer related to the subject material or a general answer. In this case detailed diagrams were not sufficient if they did not convey the essential word which was “order”. A fixed structure did not get the mark. A simple answer such as, “regular arrangement of positive and negative ions” gained the mark.
- Q14**
- (a) This question might have appeared rather easy judging that some information was provided on the data sheet. However, there were several areas which defeated candidates. One was to state that the units for energy were KJ but the definition of h is in joules. Another error was to give the value as  $\text{KJmol}^{-1}$ . There were many definitions of f given; the most predominant was the “frequency of the convergent limit of spectral lines”. Sometimes E was given as  $\Delta E$  which was acceptable if no erratic consequences were given i.e. “change of the reaction”. Rather surprisingly the question was very discriminating with a complete range of marks being obtained.
- (b)
- (i) All answers seen stated the visible region
- (ii) All answers seen stated the infra-red region.
- (iii) It was expected that candidates would say that the electron left the atom but many answers gave far more detail e.g. “the electron gains energy and, becomes excited and is lost from the atom, causing it to become positive. The majority of wrong answers were based on the electron rising to the higher energy level and then falling back down again emitting energy as light.
- (c)
- (i) The answers to this question were very surprising. They followed on from the diagram at the start of Q14 which showed the energy levels. In the case of the diagram at the start of the question the energy levels were labelled as  $n=1,2,3,4,5,6$  but in this question they were labelled  $1s, 2s, 2p$  and  $3s$ . They were different. But candidates paid little heed to the differences and used this diagram to draw on arrows which went from line to line. Some wrote one line some wrote three lines and some attempting to draw the electron structure wrote parallel lines but they went from line to line and were not written on a line. In the specification it does mention the ‘electrons in boxes’ idea but this question omitted them; despite this there was sufficient information to correctly interpret the question asked.
- (ii) All answers correctly stated either yellow or orange.
- Q15**
- (a) The ionic equation for the reaction of iron with hydrochloric acid carried a mark for the balanced equation and another for the state symbols. It was surprising to see how many candidates wrote  $\text{Fe}^{2+}$  instead of Fe. Furthermore, many candidates described the  $\text{Fe}^{2+}(\text{aq})$  when it should have been (s) if it were to represent iron metal. Besides this many of the other states of the species in the equation were often incorrect.

- (b) (i) The ionic equation for the reaction of iron(II) ions with chlorine water was better answered than the equation in Part (a). Perhaps it was because this is a learnt equation from the specification whereas that in Part (a) does not directly feature on the specification and required application of knowledge.
- (ii) Yellow or orange were the most frequently seen colours and gained the mark. There were some greens and browns and colour combinations such as yellow/green and yellow/brown.
- (iii) Just over half of the candidates realised that bromine water reacted with iron(II) ions. Although the mark scheme stated the reason in terms of bromine as an oxidising agent candidates sometimes stated that bromine was not as reactive as chlorine which was acceptable. Many who said that the reaction did not take place also said that bromine is not a strong enough oxidising agent.
- (c) (i) The calculation was correctly done by the majority of candidates. If errors were made they were usually with the units presented. A unit was needed for molarity.
- (ii) The calculation for the formula of hydrated iron(II) chloride was well done. The main error was to write the ratio of moles of water to moles of iron(II) chloride the wrong way round. The ratio should have been 6:1 and not 1:6. It was allowed to *not* carry this error through and to give the correct formula of the hydrated salt.
- Q16** (a) Although it clearly stated to draw the dot and cross diagrams for each of the fluorides there were quite a few scripts which only displayed the structure of sulfur hexafluoride. Despite this, correct answers were given in (b)(ii). When given, the structures were usually correct. A frequent problem was not to give the outer electrons of the fluorine atoms.
- (b) (i) The octet rule was well learnt and the two marks were gained. The only cases to lose a mark were those that replaced the word 'atom' by 'element' in the definition.
- (ii) It was possible to carry any error through from Part (a) to gain marks in this part of the question. The question asked whether sulfur is obeying the octet rule; consequently the use of the word "it" was correct as "it" referred to sulfur. Most candidates obtained one or two marks.
- (c) Very few candidates were caught out by the bond angle of sulfur difluoride being  $6^\circ$  smaller than the angle in a water molecule with a value of  $98.5^\circ$  being frequently quoted. The shape of the molecule was most popularly stated as being V-shaped and to a lesser extent bent. The term non-linear was not accepted and is rarely, if ever, seen in textbooks. There were no examples seen of linear molecules being drawn.
- (d) (i) The bond angle in the sulfur hexafluoride molecule was usually stated as  $90^\circ$  but there were quite a few answers that combined the  $90^\circ$  with another angle such as  $120^\circ$  or  $180^\circ$ . The octahedral shape made some candidates think of  $60^\circ$ .

- (ii) The explanation of the shape of molecules is a common feature of AS chemistry examinations and nowadays candidates have little difficulty in repeating the standard mantra for all shapes which is that the bonding electrons repel e.g. as much as possible. There is no mention of the repulsion of atoms which used to be quite popular. Marks were occasionally lost for loose answers which failed to mention that the minimum repulsions were due to electrons.
- (iii) Again this is a standard question which has been asked before in different formats. The most popular answer was that the dipoles cancelled out either because of the octahedral shape or the symmetrical shape. Sometimes candidates were led astray by thinking that sulfur and fluorine had similar electronegativities and therefore the bond was non-polar.
- (e) (i) There had been some debate in setting this question as to whether candidates would spot that this was an unusual situation because the highest boiling substance was in fact the lightest or to be chemically correct it had the smallest mass. It was not unusual to see candidates write sulfur tetrafluoride and then to cross it out once they had reached the end of the question in Part (iii). The majority did state sulfur tetrafluoride but then had little success in Part (iii) which was naturally very discriminating.
- (ii) The question specifically asked for an explanation in terms of mass. This did avoid answers which quoted lightness or heaviness which are linked to forces and not masses. However, there were many answers which dealt with electrons despite what the question asked for. On this occasion such answers were accepted but there is no guarantee that this answer will be accepted in the future for a question phrased in this way.
- (iii) In this question candidates had to show they knew what was taking place. Simply to say that the intermolecular forces either increased or decreased was not sufficient. The answer had to be linked to the dipolar forces between the sulfur tetrafluoride molecules. However, if the answer in Part (i) had been sulfur hexafluoride then the error was carried through and the answer was then related to van der Waals forces. The question was very discriminating as expected.

## Assessment Unit AS 2 Further Physical and Inorganic Chemistry and Introduction to Organic Chemistry

The paper was successful in giving all candidates an opportunity to answer at least some of the questions. The mark scheme was easy to follow. The candidates appeared to have ample time to complete the paper.

- Q11 (a) (i) The answer to this question was rarely wrong although a few candidates showed the formation of  $O_2$  instead of  $CO_2$ .
- (ii) This was generally well answered, with the majority of candidates gaining at least two marks. A few candidates discussed van der Waals forces. Candidates frequently lost marks for a lack of precision in the terminology used. For example, candidates had to refer to ions rather

than elements or atoms so, “calcium has a higher charge density” was not accepted; specific reference to the calcium *ion* was required.

- (b) This was very well answered. A few candidates lost the mark for giving “apple green” as the colour.
- (c) (i) Most candidates correctly indicated the use of water, some including the equation. The most common errors included reduction and the use of acid. Again incorrect use of terminology prevented some candidates from scoring the mark e.g. “hydrolysis” was not accepted in place of reaction with water.
- (ii) This again was given correctly by the vast majority of candidates. The most common error was to simply state “increases” without specifying “down the group”.
- (iii) This equation was almost always correct. Rare errors included the wrong formula for barium sulfate and the production of hydrogen instead of water.
- (iv) This colour was very well known. A few candidates gave yellow, obviously using the test on the next page.
- (d) Only a minority of candidates gained full marks. The most common error was not stating the use of *solutions* of potassium chromate or magnesium ions as appropriate and hence this became a very discriminating question. Other errors were using sulfate ions to test for barium ions and acid to test for carbonate ions which, of course, will also give the same result for hydrogencarbonate ions.

Q12

- (a) (i) The answer to this question was almost always correct.
- (ii) Errors carried through from (a)(i) meant that virtually all candidates gained the mark.
- (iii) Again this was well understood with few mistakes. Many candidates had simply memorised the statement given on the CCEA Clarification of Terms document.
- (b) The concept of van der Waals forces was well understood and most candidates gained at least one mark. A small number of candidates also mentioned hydrogen bonding, which nullified the mark for van der Waals forces. Many candidates stated that icosane had a “longer chain” or was “a bigger molecule” but failed to mention molecular mass or number of electrons and correspondingly did not score this mark.
- (c) (i) It was remarkable how many candidates lost this mark as it was arguably the easiest mark on the paper. In spite of the ease, a lot of candidates forfeited the mark by not quoting units in their answers. Examiners expect units to be stated at all times.
- (ii) This calculation was generally well done. The first step was almost always correct.
- In the second step the main errors were in using the mass of the icosane (0.9 g) instead of the mass of water (150 g) and in the inclusion of a negative sign which should not have been inserted at this stage as the question is asking for the heat energy transferred rather than asking for an enthalpy change.

Any errors were carried through to the final part of the calculation and so candidates penalised earlier in the question often gained the final three marks. The main error in the third stage was the omission of the negative sign. Many candidates still have a problem with the rounding of numbers and a lot of candidates displayed distinct mathematical inaccuracy by writing a calculation on their script but reporting an answer obtained by carrying out a slightly different calculation using figures stored on their calculator. As examiners can only mark what they see on the script they had to penalise candidates who wrote a calculation and then went on to record an answer that was different from the answer yielded by the calculation they had written.

- (iii) A variety of answers were seen but most candidates identified heat loss to the surroundings as the major source of error. A few candidates simply stated “heat loss” without explanation and so lost the mark. A number of candidates made reference to average values being used in the data book, obviously confusing this with bond enthalpies. The question asked for reasons for the “significant” difference in values and it was deemed incorrect to suggest that heat loss to the can would give rise to a significant difference.
- (d) (i) This was very well answered with few mistakes. Any errors in the formula of icosane were carried through from (a)(ii). Balancing was sometimes incorrect which is surprising for such a straightforward equation.
- (ii) The majority of candidates got this question correct. Some wrote the name of the compound (carbon monoxide) but they lost the mark as the question asked for the formula. Water and carbon were seen occasionally.
- Q13** (a) A lot of candidates simply stated the definition of a catalyst but this is not what the question asked for. It is still very common for candidates to rush a simple question like this, write the answer that they *think* the question is eliciting, and thereby lose the marks. A few candidates did not mention energy, as stated in the question, and lost marks accordingly.
- (b) (i) This was quite well known although a number of candidates mistakenly thought that a decrease in temperature would favour the endothermic process.
- (ii) This was better answered than the previous part with most candidates giving a very clear answer and gaining both marks.
- (iii) Although it had been anticipated that the reaction ratio would cause difficulty here, a lot of candidates gained full marks. The most common error was failure to include the moles of nitrogen in the third step. As was the case earlier in the paper Question 12(c)(i) it was common for candidates to lose a mark for units.
- (c) This was very well answered although a lot of candidates referred to the “catalytic converter” being poisoned, rather than the catalyst being poisoned. Some candidates simply stated “lead poisoning” but as this is a medical term it was not deemed to be specific enough to the context of this question and hence they lost the mark.



- Q14**
- (a) The term primary alcohol was well understood by the vast majority of candidates. However, some candidates misunderstood the question and explained why ethanol was a primary alcohol. For example, “it has only one methyl group attached to the carbon which is bonded to the OH” did not score the mark because the question did not ask why ethanol was a primary alcohol but rather what does the term ‘primary alcohol’ mean.
- (b) The effect of alcohol on drivers was very well known but candidates were often let down by their use of English. Alcohol was frequently stated as “reducing reaction times” which is the opposite of what the candidates no doubt intended to convey, “reduces driver’s reaction speed”. This was extremely common and it led to this simple question becoming quite discriminating.
- (c) (i) This colour change was very well known. Occasionally it was given the wrong way round.
- (ii) This equation was reasonably well written. Candidates could have written either the equation for the formation of ethanal or ethanoic acid. The most common error was the failure to include water in the products, with hydrogen seen instead.
- (d) (i) Virtually all candidates stated that infrared radiation caused vibrations in molecules but a lot of candidates did not mention that the infrared radiation was first *absorbed* by the molecules. Strictly speaking, the absorbance of infrared radiation causes the molecules to vibrate *more* than was already the case, but any mention of vibration scored the mark on this occasion.
- (ii) Most candidates were able to gain at least one or two marks in this question with many gaining full marks. Most commonly a mark was lost for not referring to both spectra as requested in the question.
- (e) Poorly answered by many candidates. Chloroethane was often given in place of ethanoyl chloride. The formula of sodium ethoxide was not well known and the sodium was frequently shown with a covalent bond to the oxygen which caused many candidates to lose the mark.
- (f) (i) The name of the ester was generally correct with the most common error being “propyl ethanoate”.
- (ii) Sulfuric acid was generally named as the catalyst but was not specified as being ‘concentrated’ so losing the mark.
- (iii) Most candidates gained at least one mark. Frequently the term ‘rate’ was missing when describing the forward and reverse reactions, for example, “the forward and reverse reactions are equal” was a common incorrect response. Once again, a lack of precision cost some candidates the mark for equilibrium as they stated that “the amounts of reactants and products are *equal*” which is incorrect. This response implies that there is exactly the same amount of reactants and products at equilibrium whereas a correct response would have been “the amounts of reactants and products are *constant*.” As with Question 14(b) it was apparent that candidates knew what was happening but were unable to convey it accurately.

- (iv) Many variations of spelling for the reagent were seen. This was a useful discriminator. Common errors included “propyl chloride” and “propanyl chloride” instead of the correct answer, “propanoyl chloride”.
- Q15**
- (a)
- (i) This was reasonably well done. Some candidates gave the equation for the substitution reaction and others added HCl instead of Cl<sub>2</sub>.
- (ii) A lot of candidates gave dichloroethane without the correct numbering and lost both marks. Some candidates made an error with the numbering (e.g. 1,1-dichloroethane) and lost one mark.
- (iii) This term was well understood but yet again on this paper candidates were losing marks because their answers lacked the correct detail. To simply state “breaking down large molecules” did not score the first mark. This response could imply that molecules are broken down into atoms when in fact the correct precise definition is “breaking down large molecules *into smaller molecules*”.
- (iv) Reasonably well answered although a lot of candidates stated “hydrochloric acid”. Another common error was hydrogen.
- (v) Most candidates correctly gave addition polymerisation but there were still a few giving “additional” polymerisation which lost the mark.
- (b)
- (i) This was generally well answered. The most common error was the omission of the outer electrons on the chlorine atom. A few candidates gave the dichloroethane molecule.
- (ii) The mechanism was well known. A few candidates used HBr and still scored two marks. Some candidates gave partial charges rather than full charges on the ions in the middle of the mechanism.
- (iii) This was generally answered correctly. There were the usual mistakes involving “nucleophilic” and “substitution”.
- (iv) This was quite well known. The most common error was to state that the C=C was broken. A small number of candidates thought it was the sigma bond.
- (c)
- (i) Most candidates identified UV light. A range of general experimental conditions were also seen.
- (ii) Again this was well known. A lot of candidates used CH<sub>4</sub> and were penalised accordingly, with the error carried through so that they could still score one mark.
- (iii) Well answered. Carrying the error through from the previous part helped a number of candidates who had written “ethane”.
- (d) The equation was well answered by the more able candidates, weaker candidates struggled. The name of the amine was without doubt the most poorly answered question on the paper with some form of a nitrile being the most commonly seen answer.



## Assessment Unit A2 1 Periodic Trends and Further Organic, Physical and Inorganic Chemistry

- Q11** This question was very well answered by most candidates. There were a small number of references to “Haber-Bosch diagrams” and “Born-Harbour cycles”. As expected, in (c) a significant number of candidates did not scale the atomisation enthalpy of chlorine and/or the electron affinity by a factor of two. Candidates should be reminded to include units when a quantity has been calculated.
- Q12** In (a) most candidates made reference to the restricted rotation about the C=C. The idea that each carbon atom in the C=C had two different atoms/groups attached was often missed. In (b), many candidates did not have two ethanol molecules on the left or two water molecules on the right. The structure of the monoester was also common. Oxygen atoms were often missing from the formulae/structures of the esters. The main error in (b)(iii) was not indicating that the acid was concentrated. In (c) a surprisingly large number of candidates did not indicate that heating was required.
- Q13** The formulae required in (a) were well known as was the definition of the term ‘amphoteric’. Some candidates suggested that aluminium oxide can behave as a “proton donor”. The equation for the reaction of aluminium oxide with sodium hydroxide was less well known than that for its reaction with hydrochloric acid. The dot and cross diagrams for  $\text{Al}_2\text{Cl}_6$  were of a very high standard and the concept of a dimer was well understood. The behaviour of phosphorus(V) chloride when added to water was very well known. The same could not be said of the behaviour of sodium chloride. A very significant percentage of the candidates suggested that sodium chloride reacts with water to form hydrochloric acid and sodium hydroxide.
- Q14** In general, candidates scored very well in this question. The definitions of iodine and saponification values were well known and, based on the calculations, well understood. Calculations of this type could now almost be classified as knowledge rather than application since candidates seem to be so familiar with the sequence – some candidates merged two or three calculation steps into one. The procedure for determining the iodine value was very well known with most candidates scoring 5 or 6 marks for the knowledge and 2 for the quality of written communication. The structure of the fat did prove challenging for some candidates but marks could be scored in (d)(ii) by carrying an error through.
- Q15** Relatively few candidates indicated that hydrogen has an enthalpy of formation of zero since it is an element. The calculation of standard enthalpy and entropy changes did not prove too challenging for most although there is a tendency with a small number of candidates to quote a number with no units. It is important to be consistent with units when calculating the temperature at which the reaction becomes feasible and most candidates were tuned in to this idea. Most converted the entropy change to kJ per Kelvin per mole. Some candidates used square brackets in the expression for  $K_p$ . The most challenging part of the calculation was finding the number of moles of each species present at equilibrium. However, when mistakes were carried through, many candidates still scored well.
- Q16** In (a), the indicator was well known. However, the expected result was not well answered with many candidates giving blue-black to colourless. The graphs were well answered, particularly the direct proportion relationship in the second graph. The orders with respect to hydrogen peroxide and hydrogen ions were largely correct. Some candidates left the concentration of iodide ions out of the rate equation. The

fact that the initial rate of reaction needed to be scaled down by a factor of  $10^6$  was missed by many candidates. The units for the rate constant were usually correct. Although the definition of rate determining step proved to be easy for most, figuring out the equation for the second step proved too difficult, with some very strange suggestions given. Very few candidates seemed to check to see if the first and second equations added to produce the overall equation.

**Q17** Parts (a)–(c) were very well answered. A small number suggested the formation of a white solid in (a)(i). The sketch of the titration curve was, in general, very inaccurate. Many candidates did not seem to link the initial pH with the value calculated in (c)(ii) and started too far up the y-axis. The position of the vertical portion was often too far from half way across the x-axis and often not “vertical” enough. The final pH was often too high. Definitions for a buffer solution were good but the explanations of how this buffer works were often confused and contradictory. The strongest candidates gave clear and logical steps in the final calculation. Many other candidates showed a lack of understanding of what actually happens to the amount of the weak acid and its salt when an alkali is added. Sodium hydroxide was treated as the “salt” by many. Some candidates scored high marks by carrying an error through.

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