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# **GCE A LEVEL EXAMINERS' REPORTS**

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**CHEMISTRY  
A LEVEL**

**SUMMER 2019**

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## CHEMISTRY

### GCE A LEVEL

Summer 2019

#### COMPONENT 1 - PHYSICAL AND INORGANIC CHEMISTRY

##### General Comments

The paper differentiated well with over 90 marks between the lowest and highest marks attained. There were some questions which proved accessible to all candidates, with 17 being the lowest mark, and some questions which challenged even the best candidates. Each question on the paper showed a wide variety of marks, and no question proved inaccessible to all candidates. Almost all candidates attempted all questions, with no indication that candidates were unable to complete the paper in time.

Recall of facts was a strength for many candidates and it was clear that the shorter questions were most accessible, but candidates that had not learnt their work thoroughly were penalised here, even though they gained marks on questions that were more challenging. Examples of recall questions where marks were lower than expected included questions 2, 12(b) and 12(d)(i). The QER questions showed a significant improvement this year, with fewer answers in the lowest band, especially in question 11(b)(ii) on periodicity.

Practical methods remain an issue for many candidates and their ability to evaluate and improve quantitative practical methods is an area that needs improvement, although qualitative work has shown improvement this year. Some candidates also lacked precision in their explanations and their use of terminology. Examples include discussions of van der Waals forces between atoms in iodine or selenium [questions 5 and 11(b)(i)], identifying a halide as iodine [question 9(b)(iii)] and giving the formula of an ion as 'copper' [question 10(d)(i)]. In calculations the misuse of units, especially with SI prefixes, was less prevalent this year, although a few candidates still do not remember to convert between J and kJ when calculating Gibbs free energies. Questions that required candidates to undertake unfamiliar calculations which require thought, such as 10(e), 12(c) and to a lesser extent 13 (a)(v) still challenge all but the best candidates. Electrochemistry remains the most challenging concept for many.

##### Comments on individual questions/sections

###### Section A

- Q.1 Almost all candidates were able to place an appropriate number of arrows in the boxes. A very few filled the d sub-shell rather than place electrons in the 4s.
- Q.2 The use of carbon-12 as the standard was recalled correctly by almost all the candidates. Some did not mention one-twelfth of the mass and a very few referred to a mole of carbon-12 whilst this question refers to an atom.
- Q.3 Candidates who realised that magnesium fluoride was ionic generally gained both marks. It was disappointing to see a significant number of covalent representations. In a small number of poor answers the symbols used were incorrect, with 'MG', 'FI' and even 'Mn' appearing amongst the answers.

- Q.4 Most drew both diagrams correctly, with errors more common in the first part than the second. The most common errors were energy distributions for lower temperatures or lines that crossed the original distribution at high energies. In the second diagram a few drew the lower activation energy but did not show how this affected the number of particles with enough energy to react.
- Q.5 There were many good answers here although a few referred to one element only and ignored the other. Some failed to refer to the intermolecular forces in iodine whilst others referred to intermolecular forces in diamond.
- Q.6 Most associated the colour changes with the loss and gain of water ligands. The quality of many explanations was poor.
- Q.7 Almost all candidates calculated the value correctly with a few penalised for significant figures.
- Q.8 The quality of the calculations here was very good. Only a handful of candidates made errors in the first part. Most candidates gained marks in the second part although a few missed the 5:1 reacting ratio.

## Section B

- Q.9 (a) (i) Almost all could recall  $\text{pH} = -\log [\text{H}^+]$ .
- (ii) This was written correctly by most. A few wrote a generic version based on acid HA or HX rather than the specific acid requested.
- (iii) The answers to this QER question were of a good standard. Most candidates could discuss the differences between strong and weak acids and discuss how the concentration of  $\text{H}^+$  ions would change in a strong acid. Candidates were differentiated by their qualitative discussion of  $\text{H}^+$  concentration in weak acids and their quantitative work. It was surprising to see candidates that had calculated two pH values that showed a lower pH when acid concentration increased still writing that pH value would increase.
- (b) (i) The preparation of a soluble salt is one of the specified practical tasks that all candidates should have performed. Few candidates showed an understanding of this method here. Many discussed precipitates despite the (aq) state symbol included in the equations. Most understood that evaporation of the solvent would be required but a significant number then washed their soluble crystals with water.
- (ii) This was very well answered and the majority of candidates gained all three marks.
- (iii) Most realised that the halide was iodide although a few named it iodine. Some explanations were superficial with candidates stating that chloride and bromide didn't give a rotten egg smell, or didn't produce hydrogen sulfide. Most discussed the reasons in terms of redox and gained credit for this.
- (c) (i) This was well answered. Most clearly discussed the movement of electrons, although a few discussed the *atom* being excited and returning to its ground state with no reference to electrons and were penalised for this.

- (ii) Most candidates gained credit for this question, however many did not gain full marks. Transforming units such as kJ and nm caused problems for some, whilst others did not include Avogadro's number in their calculations to convert from molar to atomic values.
- Q.10 (a) There has been an improvement in answers related to modification of inorganic analysis methods and now the majority can explain why some acids are appropriate and others not. Most named nitric acid here as the most appropriate acid and could refer to the effects of other acids on the tests performed.
- (b) Few failed to identify chloride here. Calculating the moles of precipitate challenged a minority, with  $M_r$  values equivalent to Cl, Cl<sub>2</sub>, AgCl<sub>2</sub> and AgCl<sub>3</sub> all seen in answers.
- (c) This was poorly answered and many candidates showed a lack of understanding of the need for both cations and anions in an ionic compound.
- (d) (i) Most associated the blue colour with copper but despite the words **formula** and **ion** being in bold, some candidates gave answers that were neither.
- (ii) Many of the answers here were vague. Some candidates understood that a substance needed to be pure to find moles from mass over  $M_r$ . Others incorrectly discussed oxidation, burning or formation of copper(II) carbonate.
- (e) (i) This was answered correctly by most. Only the weakest candidates could not apply the expression for pH.
- (ii) Candidates found this challenging and only a minority obtained the correct answer. A common error was to use 150 cm<sup>3</sup> as the volume of acid used to make the solution rather than the complete 250cm<sup>3</sup>.
- (iii) Most candidates gained some credit here, for instance by combining the ions identified in earlier parts. Only the best gained full marks.
- Q.11 (a) The answers here were often vague. References to partially filled p-shells or stating there were electrons in p-orbitals without any further details were common.
- (b) This QER was generally well answered. The ideas of periodicity were applied to suggest correct values for electronegativity and electrode potential in almost every answer. The value suggested for ionisation energy was not always correct. Trends in electronegativity were well known and many candidates could explain these trends. The trends in ionisation energy within a group were applied well, however some did not realise that the pair of elements As and Se were in groups 5 and 6 leading to an expected decrease in ionisation energy. The trend in standard electrode potentials could be identified and applied by most candidates, but fewer could link this to the inert pair effect.
- (c) Radioactivity is familiar to most candidates and most gained the marks in parts (i) and (ii). A very few candidates thought that there were 8 half-lives in part (i) rather than 3.

- (d) This was a standard reacting mass and yield question and most candidates gained both marks.
- Q.12 (a) There are many uses of the element chlorine and most candidates could name one. A few gave uses of chlorine-containing compounds and did not gain credit, although a few avoided this by stating that chlorine was used in the production of these compounds.
- (b) Many gave the equation for the cold aqueous reaction rather than hot concentrated reaction. Those that recalled the products could balance this challenging equation.
- (c) This was a challenging calculation but many candidates could identify the correct percentage. The number of significant figures was a problem for many, as the data in the question and on the data sheet included values with three significant figures and two significant figures. About half the candidates realised that the answer should be to two significant figures.
- (d) (i) The recall of the process of ionisation in the mass spectrometer was good. The recall of the separation process was not of the same standard with some referring to the charged plates being responsible for separation and others not referring to the mass to charge ratio.
- (ii) This question distinguished well with a full range of marks seen in a wide range of answers. Some candidates gave answers to part (i) with sufficient detail to answer parts (i) and (ii) and were credited with full marks. A few candidates could not recall the 3:1 abundance ratio of isotopes for chlorine and used other ratios in part (ii) which prevented them from accessing these two marks.
- (e) (i) Most could identify the trigonal planar shape although a few neglected to include the bond angle required.
- (ii) Most referred to the formation of coordinate bonds but not all stated that the electron-deficient aluminium and the lone pair on chlorine were involved.
- (iii) This question challenged many. The question does not require the shape of either species but an explanation of why they are different. Some spent their efforts on trying to identify the unfamiliar shape of  $\text{ClF}_3$  despite the question stating that this was not needed. A common misconception was to state that  $\text{ClF}_3$  had ONE lone pair rather than two lone pairs. Almost all candidates could explain why lone pairs made a difference to the shape adopted by a molecule. A few did not compare the two molecules stating that there were lone pairs in one or no lone pairs in the other.
- Q.13 (a) (i) Most candidates gained marks here with discussion of the effects of pressure on percentage conversion present in almost every answer. Fewer discussed rate or equipment costs, energy costs or safety but the best answers covered all three areas.

- (ii) Almost all candidates could give at least one reason why the value given was not the standard enthalpy change. Some realised that two ammonia molecules were formed, whilst others focused on the standard conditions. A few lost marks by discussing standard states. All of the species involved here are gases as written in the equation.
  - (iii) Almost all candidates could write an expression for  $K_c$ . The few incorrect answers were often not due to misconceptions but due to careless errors e.g. writing the formula of nitrogen or hydrogen incorrectly.
  - (iv) This was well answered with most able to link Le Chatelier's principle to the value of  $K_c$ .
  - (v) This challenged many candidates with a variety of incorrect answers and a minority of correct answers. It was common to see candidates assuming  $0.002 \text{ mol dm}^{-3}$  of nitrogen had reacted leaving  $0.018 \text{ mol dm}^{-3}$  rather than  $0.004 \text{ mol dm}^{-3}$  reacting. Many error carried forward (ECF) marks were awarded in this question.
- (b)
- (i) Most had an idea regarding the stability of these molecules but did not express it well. Some referred to one molecule only despite the question stating 'these molecules'.
  - (ii) Most calculated the values in parts I and II correctly. The few errors were generally in part II with candidates forgetting to convert kJ to J, or using the answer to part I rather than the enthalpy given with the equation. Part III divided candidates – some had learnt that the temperature was the minimum temperature for reaction whilst others considered the data and realised that the Gibbs free energy became positive above this temperature.
  - (iii) There were many different correct answers given here and these were all awarded marks.
  - (iv) The use of electrochemical potentials to determine feasibility is frequently a challenge for candidates, especially where candidates must select which values to use. In this case there were two half-equations involving hydrazine, one acting as an oxidising agent and one acting as a reducing agent. Many candidates were unsure as to which one to use, and the question differentiated well between candidates who understood the concepts and those that did not. Those that could identify the appropriate half-equation almost all gained both marks in part II and most gained the marks in part I, although a few could not make the link with Le Chatelier's principle.
- Q.14 (a)
- (i) Most gained marks here although some tangents were too divergent to give a value within the accepted range. The units were correct for most.
  - (ii) Most used half-lives to prove the first order relationship but some stated a half-life of 8.5 s rather than 8500 seconds and so only gained one of the two possible marks. A few calculated a second rate and gained the marks in this way.

- (b) This question required candidates to apply ideas from their practical work to unfamiliar situations. Only a few candidates could apply the idea of a fair test to appreciate the idea of pseudo first order conditions and most thought that it was to ensure the reaction was fast enough or slow enough.
- (c) Most gained the mark in part (i) and could suggest reasons in part (ii). Answers in part (ii) often lacked key elements with some stating that the experiment was repeated with different water concentrations without reference to keeping the other concentrations constant.
- (d) (i) Most could write the unit of the rate constant correctly.
- (ii) The Arrhenius equation includes some of the most advanced mathematical work in the component, with rearranging exponential equations and using natural logs challenging many candidates. Despite this, questions involving this equation are generally answered well. Rearranging to produce an expression for  $T$  is possibly involves the most challenging mathematics, however it was pleasing to see so many performing this correctly and expressing their answer in a variety of correct ways. The most common rearrangement 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 0.29 K, and it was disappointing to see that some candidates did not identify this as an unlikely temperature for the students to use. It is important that candidates appreciate that the answers to calculations in their chemistry work have real world meanings and should look at each answer and ask if the answer makes sense.

### Summary of key points

- Naming halogens and halides causes problems for many candidates. It is not acceptable to use iodine and iodide or chlorine and chloride interchangeably. In question 5 some candidates referred to iodide and were penalised, as were those that referred to a chlorine ion in 10(b) or and iodine ion in 9(b)(iii). It is important that candidates are aware that incorrectly naming any species may make their answers incorrect.
- The skills developed in practical work are relevant throughout the chemistry components. Practical techniques need to be recalled e.g. in question 9(b) but an appreciation of why some reagents or certain concentrations are used is also tested. We have seen an improvement in candidates grasp of qualitative techniques however there remains work to be done on their understanding of the quantitative approaches.
- Candidates need to appreciate the need for appropriate numbers of figures or decimal places in measurements and significant figures in calculated values. Certain measurements must be given to a specific number of figures, such as titration measurements to two decimal places. One decimal place values will be penalised. Where a certain number or 'appropriate number' of significant figures are required in the question it is not be possible to gain full marks for a calculation if this is ignored.



**CHEMISTRY**  
**GCE A LEVEL**  
**Summer 2019**  
**COMPONENT 2 - ORGANIC CHEMISTRY AND ANALYSIS**

**General Comments**

This was the third occasion that this paper has been set and the examiners felt that it was generally quite accessible, but as last year, some questions proved more challenging. As on previous occasions the more challenging questions proved to be those where candidates had to apply their knowledge to new situations. In general, the mathematical elements of the paper was handled very competently. Again, it was disappointing to see that questions that had a focus on the practical aspects of the qualification were, in general, done less well.

This Component 2 paper has a 2½ hour duration and there no evidence suggesting that candidates had to rush their answers to complete it.

The responses to this paper again produced a very wide range of marks from about 20 to about 110. The number of weaker scripts was a little higher than in previous years but a good number of candidates scored 80 marks or more.

**Comments on individual questions/sections**

**Section A**

- Q.1 (a) Nearly all candidates knew that the addition of hydrogen cyanide to a ketone was an example of a nucleophilic addition reaction.
- (b) The reagent for the hydrolysis of a nitrile to a carboxylic acid was often given as hydrochloric acid or aqueous sulfuric acid. Those who gave sulfuric acid without indicating that water was also present lost the mark.
- (c) Most candidates were able to provide the correct empirical formula for compound X.
- (d) Nearly all candidates knew that lithium tetrahydridoaluminate(III) would reduce the carboxylic acid to the corresponding primary alcohol.
- Q.2 (a) The reagents and conditions for diazotisation were both well understood and few candidates failed to gain both marks.
- (b) The reason why the azo dye appears yellow in white light was generally given correctly.
- Q.3 Many candidates realised that benzamide would react with aqueous sodium hydroxide on warming to give an aqueous solution of sodium benzoate. To gain this mark it was also necessary to indicate that ammonia was a co-product and that it was lost from the system as a gas.

- Q.4 There are a number of chemical tests that can be used to differentiate between solutions of benzoic acid and 2-hydroxybenzaldehyde and candidates could focus on a positive test with either compound. Many candidates gained both the available marks for this question.
- Q.5 This question asked candidates to give the displayed formula of calcium ethanoate. The question emphasised that a full displayed formula showing all the bonds was required. Although a number of candidates gained the mark here, a large number indicated that only covalent bonding was present and forgot that the salts of carboxylic acids are ionic. They needed to show the calcium as a cation and the ethanoate ion as an anion.
- Q.6 The methyl radical should have shown three bonding pairs between carbon and hydrogen and a single unbonded electron on the carbon atom. This was often correct but charged radicals and incorrect numbers of electrons were sometimes seen.
- Q.7 (a) Most candidates were able to obtain the correct answer of 35% but sometimes the relative molecular masses were calculated incorrectly and/or the stoichiometry of the reaction was not considered.
- (b) The correct answer of 66.6% was generally given by most candidates.

## Section B

- Q.8 (a) (i) Most candidates could relate the chlorination of methylpropane to the chlorination of methane and gained the mark available.
- (ii) This question was not answered well as it was necessary to state that polychlorination occurred by the reaction of a chlorine radical/atom on the chlorinated alkane already produced. The answers provided were not always very clear and consequently a mark was lost. It was possible to score this mark by stating that two chlorinated alkyl radicals could also react together to give a polychlorinated product and this was sometimes seen.
- (iii) This was a challenging question and few candidates were able to give a reasoned answer. Many spoiled their response by writing about the stability of various types of carbocations but this is a radical reaction and no carbocations are present.
- (iv) Many candidates gave the correct formula for the compound (2,2,3,3-tetramethylbutane) but did not then go on to say that all the hydrogen protons in this alkane were in the same environment or equivalent. They lost the explanation mark.
- (v) The equation for the complete combustion of methylpropane was generally correct.
- (b) The equation producing a chlorine radical and a fluoromethyl radical was often correctly given. Fewer candidates could go on to write about the comparative stability of the C—F and the C—Cl bonds.

- (c) This numerical question about methane clathrate was generally done very well and most candidates worked through the information given to confirm the answer provided in the question.
- (d) (i) Many candidates gained credit for emphasising the toxicity of hydrogen cyanide. Some pointed out the high temperature needed for this method of destroying CS gas.
- (ii) I A surprising number of poor answers were seen in this question. The examiners required candidates to imply that hydrolysis meant the decomposition of the compound by its reaction with water. Too often we read that 'water was added' and this was not enough for a mark.
- II A complete answer here included reference to filtering, washing and drying. Candidates were credited for 'filter and dry' but some missed out the drying stage.
- III Almost all candidates knew that impurities reduce the melting temperature of the pure compound and cause it to melt over a temperature range.
- IV The answer was 'decarboxylation'. Many candidates gained this mark.
- V The answer to this calculation was 24.8 kg and it had to be given to three significant figures for full credit to be awarded. Some candidates became confused in the calculation but were still able to gain two or three marks,
- Q.9 (a) This was the first of the 6-mark questions that tested the quality of extended response (QER). Of the six compounds given, four were required to be identified by the use of infrared spectroscopy.  $^1\text{H}$  NMR was to be used for the remaining two compounds. The examiners thought that the infrared aspect was answered very well. The use of NMR data to identify compounds B and E was more difficult and not so well done. Weaker candidates gave little detail about the splitting pattern and the peak ratios of the signals. Nevertheless, a mark of 4 or more was commonly awarded.
- (b) This question asked candidates to suggest a formula for an aromatic compound of formula  $\text{C}_6\text{H}_8\text{Br}_2$ . Many gained full credit. Others usually did not realise that only one of the bromine atoms was removed by hydrolysis with sodium hydroxide. These candidates gave a structure with both bromine atoms on the side chain.
- (c) (i) I This question on gas chromatography provided an easy mark for almost every candidate.
- II The formula of limonene does not fit the general formula of an alkane (having too few hydrogen atoms) so it must therefore be unsaturated. Most candidates deduced this and then gave the correct molecular formula.
- (ii) I Rather surprisingly a number of candidates gave the name as 2-methylphenol rather than the 3-isomer.

- II Most candidates stated correctly that the reagent used was 2-chloropropane. The commonest catalyst given was  $\text{AlCl}_3$  although  $\text{AlBr}_3$  and  $\text{FeCl}_3$  were also accepted.
- III Reduction and hydrogenation were the commonest correct answers.
- (iii) Almost all candidates were able to give the skeletal formula of menthane.
- Q.10 (a) (i) It was unusual to see an answer other than the correct 'electrophilic substitution'.
- (ii) Not every candidate suggested that further substitution had occurred to produce other methylbenzenes.
- (iii) It was necessary to state the correct oxidation number for manganese if candidates used potassium manganate(VII) as the oxidising agent. Candidates who gave  $\text{KMnO}_4$  also gained the mark.
- (iv) I Candidates were required to balance the equation by adding  $2\text{SO}_2$  and  $2\text{HCl}$ . A surprising number of candidates gave hydrogen or even water instead of hydrogen chloride as one of the products.
- II Most candidates realised that  $\text{SOCl}_2$  was the preferred reagent as the co-products were both gaseous.
- III Recognising that ethanol will react with both the acid and  $\text{SOCl}_2$  was a straightforward mark for many candidates. Those who stated that an ester is formed gained no credit.
- (v) The examiners were looking for mention of the peptide linkage or its formula for the mark to be awarded.
- (vi) The answer for the conversion of  $-\text{NH}_2$  to  $-\text{OH}$  was nitric(III) acid but a number of candidates gave  $\text{NaOH}$ .
- (vii) The formula for the repeating section of the polyamide was generally given correctly.
- (viii) I Most candidates gained both marks for describing the low resolution  $^1\text{H}$  NMR spectrum of the substituted diamide.
- II Although a number of candidates were able to state that this amide had four  $^{13}\text{C}$  NMR signals, fewer were able to identify the carbon atoms responsible for this spectrum.
- (b) (i) Very few candidates failed to show the correct formula of the protonated cysteine.
- (ii) I Most candidates calculated  $M_r$  of ethanoic anhydride correctly and went on to show that the volume of ethanoic anhydride required was  $23.6\text{ cm}^3$ .

- II This was an easy calculation for nearly all candidates, who showed that the mass obtained was 36.7 g.
- (iii) The displayed formula of aminoethanoic acid was the most common correct answer.
- Q.11 (a) (i) Although most candidates gave the correct equation, there were a significant number who could not recall the formula of hexane.
- (ii) I Many candidates lost this straightforward mark by not mentioning the need to remove the stopper before attempting to separate the two layers.
- II Nearly all candidates gained both the available marks for separating the two liquids by distillation using a heat source other than a naked flame.
- (b) (i) There were four marks for this calculation and it was pleasing to see that many candidates tackled this question in a well set out and methodical manner and gained full credit for their efforts.
- (ii) Most candidates were able to provide the molecular formula of ectocarpene and then go on to give a structure for an aromatic isomer of this compound.
- (c) (i) The structure of the diol produced by the reduction of compound W was generally given correctly.
- (ii) Many candidates described the reaction of compound W with Tollens' reagent and provided an explanation for the appearance of a silver mirror.
- (d) Although many candidates gave the correct structure of 2-methylbutanoic acid, a number gave the structure of 3-methylbutanoic acid, forgetting that the acid group carbon atom counts as number 1 in the naming of the compound. Many candidates were successful in drawing the structure of the isomer of 2-methylbutanoic acid that fits the description given.
- Q.12. (a) This was the second of the QER questions. The question asked candidates to discuss the intermolecular bonding in a series of compounds. The responses were very encouraging with many answers scoring 5 or 6 marks.
- (b) (i) The question asked why sulfuric acid acts as a catalyst in the dehydration of an alcohol. Candidates were required to mention that the acid is 'not used up' or that it is 'regenerated'. Some candidates stated that the catalyst did not take part in the reaction but this was not credited.
- (ii) Nearly all candidates knew that that the alcohol acted as a 'lone pair donor' or a 'proton acceptor'.
- (iii) The reasons for the formation of the alternative alkene product were generally provided but they were not always clearly expressed.

- (iv) Most candidates used the molar volume of a gas to answer this calculation and obtained the correct answer of 0.8 g of 2-methylbutan-2-ol.
  - (v)
    - I Nearly all candidates correctly wrote that peak B must be given by 2-methylbut-2-ene as this was the major product of the reaction.
    - II This question was more challenging and the examiners hoped that candidates would mention the retention time comparison with a known sample. This was seldom seen and more complex suggestions were often seen involving mass spectra or chemical tests on the separated products.
  - (vi) The formation of the ether by dehydration of the alcohol proved difficult for many candidates. The simplest acceptable response was to state that the ether was formed by the loss of a water molecule from two molecules of the alcohol.
  - (c)
    - (i) The structure of the monomer of PLA was well known.
    - (ii) There were a number of acceptable answers to this question. A number of candidates lost one or both marks by simply repeating information given in the question.
- Q.13
- (a) This calculation was very well done.
  - (b)
    - (i) The reasons for the lack of E-Z isomerism in 2-methylhept-2-en-6-one were well known.
    - (ii) Nearly all candidates were able to draw an isomer of this ketone that did show E-Z isomerism.
    - (iii) The reagents and the observation for the triiodomethane test were often provided correctly. Some candidates however gave the reagent used as triiodomethane.
    - (iv) A large number of candidates gained both marks for showing the structure of the reduction product and the chiral centre present in the compound.
  - (c)
    - (i) The answer to this calculation was  $317 \text{ kJ mol}^{-1}$  and many candidates scored all three marks. Some used incorrect equations relating energy, frequency and wavelength and errors in changing units were common.
    - (ii)
      - I Many candidates gained both marks for writing that bromine was decolourised and that a white precipitate would be formed.
      - II Electrophilic addition was given by most candidates.
      - III This was a straightforward final mark and many candidates gave the correct ratio of 4:1.

### Summary of key points

- All chemical equations must be balanced.
- Any formulae given must be unambiguous. If the type of formula asked for is in bold print then that type of formula **must** be given.
- Excessive truncation should be avoided during calculation stages.
- Numerical answers given to three significant figures would always be sensible unless otherwise suggested in the question.

## CHEMISTRY

### GCE A LEVEL

Summer 2019

#### COMPONENT 3 - CHEMISTRY IN PRACTICE

##### General Comments

This was the third setting of this paper. It proved to be successful in that it allowed all candidates to show their knowledge and understanding and differentiated well. Some marks were accessible to almost all the candidates whilst other marks were gained only by the most able. This led to a good distribution of marks with most in the range from 26 to 42. The mean mark for the paper was 31 out of 60.

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) Surprisingly poorly answered with many candidates referring incorrectly to 'heat loss to the surroundings'. Since the question stated that the value of  $\Delta T$  was **much** lower than expected the following answers were not credited:

- parallax error in reading the thermometer
- not measuring exactly 50 cm<sup>3</sup> of water
- impurities present in the solid samples used

(b) Well answered.

(c) Generally well answered, although a minority of candidates did not actually give the maximum temperature change as 5°C.

Q.2 (a) (i) Nearly all the candidates gained 4 marks for correctly plotting the titration curve and labelling the axes.

(ii) The candidates had to use the information from their titration curve to answer parts I-III.

Part I was well answered, with nearly all the candidates using the titration curve to correctly identify that 26.5 cm<sup>3</sup> of NaOH(aq) was needed for complete reaction. Candidates then used this volume to calculate the concentration of the aqueous ethanoic acid. In part II, the pH of the sodium ethanoate at the equivalence point was usually correctly given.

Part III was less well answered. Two different methods for calculating  $K_a$  were seen. Some candidates recalled that  $\text{pH} = \text{p}K_a$  at the half-equivalence point but used the pH at equivalence in the expression. They were awarded 1 mark by ECF. When candidates used the  $K_a$  expression, marks were lost through errors in rearranging and through substituting incorrect values for  $[\text{H}^+]$  and  $[\text{HX}]$  into the expression.



- (b) Well answered.
- (c) Again, two different methods for calculating the mass of sodium propanoate needed to make the buffer solution were seen.

Where candidates used the  $K_a$  expression, the first mark was awarded for the correct expression and the second for calculating  $[H^+]$  at the buffer pH of 4.46. Most candidates were able to correctly calculate  $[X^-]$  by substituting the values into the  $K_a$  expression. Only a very small minority were then able to calculate that 3.93 g of the sodium propanoate was needed to make 500 cm<sup>3</sup> of the buffer solution. The most common errors were using an incorrect  $M_r$  for sodium propanoate and not scaling down for the preparation of 500 cm<sup>3</sup> of the buffer solution.

Where candidates used  $pH = pK_a + \log \frac{[salt]}{[acid]}$  the first mark was awarded for the correct expression and the second for calculating  $pK_a$ . Reorganising this expression to calculate the concentration of the sodium propanoate was more demanding than the alternative method described above but some excellent mathematical skills were seen from some candidates.

- Q.3
- (a)
    - (i) Poorly answered with very many candidates giving the ionic equation for the reaction of  $Fe^{2+}$  with  $SO_4^{2-}$  ions rather than that for the reaction of Fe and  $H^+$ .
    - (ii) This straightforward question was poorly answered by some candidates. Some were unable to identify NaOH(aq) as the reagent to identify  $Fe^{2+}$  ions and others who gave the reagent gave an incorrect colour for the precipitate formed. Many did not balance the ionic equation for the reaction, forgetting to include two hydroxide ions.
  - (b) Most candidates correctly referred to the need to prevent oxidation of Fe(II) to Fe(III)'. Incorrect answers included 'prevent the formation of iron oxide' and 'prevent the oxidation of iron'.
  - (c)
    - (i) Most candidates calculated the mass of potassium dichromate(VI) correctly.
    - (ii) This question was generally well answered with most candidates able to describe how the student should perform one titration to find the volume of potassium dichromate(VI) needed. To gain the full four marks the answer had to include a reference to recording the initial and/or final volume of dichromate(VI) in the burette. The correct sequence of steps was essential.
  - (d)
    - (i) This question is a familiar one and it was well answered.
    - (ii) Generally well answered with the majority of candidates giving the correct equation for the reaction of  $Fe^{2+}$  and  $Cr_2O_7^{2-}$ .
    - (iii) The most common error here was incorrectly scaling up from 25 cm<sup>3</sup> to 500 cm<sup>3</sup> with many candidates scaling up to 250 cm<sup>3</sup>.

- (iv) A minority of candidates understood how to calculate the maximum percentage error in weighing the wire. However, the majority did not realise that the uncertainty of  $\pm 0.005$  g should be doubled because the balance is read twice. An answer of 0.36% was required for award of the mark.

Q.4 This was the QER question that tested the quality of the extended response. The question proved more challenging than the examiners had anticipated and a small number of candidates made no attempt. The mean mark was 1.6 out of 6. The most common weaknesses included:

- not identifying  $\text{Na}^+$  ions by a flame test
- not removing  $\text{CO}_3^{2-}$  ions by reaction with dilute hydrochloric or nitric acid before adding aqueous  $\text{Ba}^{2+}$  ions
- adding sulfuric acid to remove  $\text{CO}_3^{2-}$  ions
- not adding aqueous  $\text{Ba}^{2+}$  ions in excess to ensure the quantitative precipitation of barium sulfate
- not purifying and drying barium sulfate to constant mass before weighing

Q.5 (a) (i) Generally well answered with butanamide named incorrectly by a minority of candidates.

- (ii) Nearly all candidates gave the correct observations for the iodoform and 2,4-DNPH reactions. However, a small minority could not identify which of compounds **A-F** give positive results in these tests.

(b) Most candidates correctly explained why compound **F** gives a positive result for the iodoform reaction in terms of the methyl ketone group. However, a number failed to explain why it does not give a positive result with 2,4-DNPH and thus were not awarded the mark

(c) (i) This proved to be a challenging question for some candidates with many unsure as to the organic functional group tests. Incorrect or incomplete answers included:

- red litmus paper turning blue in butanamide solution
- not heating  $\text{NaOH}(\text{aq})$  when identifying butanamide
- not testing for ammonia gas at the mouth of the test tube when butanamide is heated with  $\text{NaOH}(\text{aq})$

- (ii) Nearly all the candidates could explain the positive result for butanoic acid and sodium hydrogencarbonate solution. Those who answered part (i) well were able to explain in terms of the hydrolysis of the amide group.

(d) (i) The most common incorrect answer given was 1-hydroxybutanal.

Parts (ii)-(iv) clearly differentiated between those that had thoroughly revised the organic functional group tests and those that had not. It was surprising to see that some A level candidates only scored 1 of the 3 marks available here.

## 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 must read questions carefully. Easy marks can be lost e.g. when values are scaled up by the wrong factor as was seen on this paper.
- Candidates should consider the number of marks awarded for a given question. Where 4 marks are available they should be expecting to make four points or to carry out four distinct steps in a calculation.

## CHEMISTRY

### GCE A LEVEL

Summer 2019

## PRACTICAL ENDORSEMENT

### General Comments

The second cycle of monitoring Practical Endorsement covered the period September 2017-April 2019. EDUQAS visited most centres doing Practical Endorsement in year one of this cycle. The third cycle of visits will commence in September 2019. Approximately 90% of centres passed on the first monitoring visit in the second cycle. This is comparable with the outcome from the first cycle of visits and similar to other Awarding Bodies. Centres which failed the first monitoring visit were supported and visited a second time in the same subject. All centres which failed the first visit made by EDUQAS subsequently passed the second visit.

Centres are commended for the way in which they have embraced Practical Endorsement. EDUQAS monitors saw many examples of good practice and assessment used by schools and colleges.

### Comments on individual questions/sections

Monitors were required to examine evidence of how the school manages Practical Endorsement. In common with other Awarding Bodies, monitors are required to view the following evidence:

- Plans for completing and assessing practical work. The centre is required to plan to complete the necessary range of practical work required by the specification.
- Teacher records of candidate assessment.
- Candidates' laboratory books.
- Teacher assessment of a practical class. The monitor is required to observe a year 13 practical class in which assessment of CPAC is taking place and speak to the teacher about the assessment of the relevant CPACs linked to the session.

There are several key features that characterise centres that successfully implement practical endorsement:

- Clear planning of both practical work and the CPAC statements to be assessed in each practical.
- Candidates are well informed about practical endorsement, the meaning of CPAC statements and the outcome of each assessment.
- Practical books are used in 'real time' at the bench by candidates when completing a practical. Practical books should be used in the lesson. We do not expect to see practical books which are in immaculate condition! Candidates should not write on scraps of paper and later copy the work up neatly into practical books.
- The teacher targets appropriate CPAC for assessment in the practical lessons.
- Suitable feedback is given to candidates. This is particularly important when a candidate does not achieve a CPAC. They should know why they have failed to achieve a CPAC statement and what they need to do next time to evidence it. We understand that there are limits to the feedback that may be given. Use peer assessment and self-assessment to reflect on practical work. Encourage candidates to self-annotate work to facilitate learning. This is particularly helpful if you give verbal feedback.

- There is evidence of good communication between staff teaching on the same qualification. Where a number of teachers are involved in the delivery of a qualification, there should be evidence that centres standardise their approach.
- Information from CPD is fed back to other members of the team delivering the qualification.

### **CPAC statements**

Centres are reminded that in order to award a pass for Practical Endorsement, a candidate needs to 'consistently and routinely meet the criteria'. This means there needs to be evidence of multiple occasions where a candidate evidences a pass for each CPAC statement. It is important that suitable opportunities have been built into the assessment plan which allow candidates to generate this evidence.

**CPAC 1** This is generally well assessed by the majority of the centres visited. In a few cases, candidates did not always carefully follow instructions during the observed practical. When this happens, the candidate should not achieve the CPAC. It is therefore important that candidates are carefully observed when they conduct their work.

When assessing more complex procedures, teachers may wish to use a check list to aid assessment. This is particularly helpful in standardising assessment when a number of teachers are involved assessing the same scheme.

**CPAC 2** This is the most difficult CPAC for candidates to evidence since it involves higher-level skills. Generally, we do not expect to see this CPAC assessed in the first two terms of an A level course. However, we do expect to see evidence of some assessment of this criterion by the beginning of the second year of the A level course. Some centres make use of the period at the end of the first year to introduce the assessment of this CPAC statement. Please make sure that you know where and when you are going to assess this CPAC. It is also important that sufficient time is given to candidates to develop the necessary skills before assessment occurs.

**CPAC 3** There is no need to assess this skill every time a practical is completed. There is no shortage of opportunities to assess this CPAC so choose the occasions where there are more significant risks or hazards.

CPAC 3(a) requires learners to identify hazards and assess the risks associated with the hazards. Some centres choose to assess this by asking candidates to write a risk assessment. This is a valid means of assessment. If a risk assessment is not written by the candidate then it will be necessary to consider how to assess CPAC 3(a). A simple method used by some centres is to ask candidates to identify to the teacher the hazards/risks of a technique while they do the experiment. Successful completion could then be marked on a tick sheet.

CPAC 3(b) should be assessed by observation of learners conduct during a practical session.

- CPAC 4
- (a) making accurate observations  
Observations should be made directly into their practical books. They should not be written on to scraps of paper and copied up later. Tables of candidates own devising should be used to record information. The tables should have appropriate headings and units. It should be noted that it is a requirement that candidates record units in the table to achieve the criteria.
  - (b) obtaining accurate, precise and sufficient data  
Please carefully check learners' data. Is it recorded to appropriate precision? Is there sufficient data? Is the data what you expect? It has been noticed that some candidates read a burette to two decimal places by adding a '0' every time without checking the meniscus carefully. Please make sure that candidates are confident about reading a burette to two decimal places. Consider using a checklist to ensure that candidates doing a titration are correctly assessed.

- CPAC 5
- Please remember the difference between CPAC4 and CPAC 5.
- CPAC 4 is about recording data 'live' into appropriate tables
  - CPAC 5 has two main elements: (1) processing data and (2) referencing information

(1) Processing data

There should be evidence of learners processing data using graphs and calculations. Centres should require candidates to draw graphs by hand on some occasions and, on other occasions, to use software (e.g. Excel) to draw graphs.

Make sure graphs are constructed correctly, i.e. there is a title, each axis is correctly labelled, points plotted correctly, an appropriate scale used etc.

(2) Referencing data

Candidates **must** show evidence of referencing sources of information. The evidence produced towards this aspect of the CPAC varies considerably among centres. Some have candidates demonstrating referencing on multiple occasions, even using the Harvard System (which exceeds our requirements), while, in other centres, it is rarely evidenced.

Opportunities for assessing referencing should be built in from early in the course. The information referenced may be, for example, data or a quote; the information may come from a textbook, journal, website, EDUQAS data sheet etc.

A few centres, and therefore candidates, still confuse referencing with a bibliography. There are important differences.

### Summary of key points

- Successful delivery of Practical Endorsement needs careful thought and planning. Ensure that you review and adapt these plans as you deliver the qualification. Make sure that there are ample opportunities for candidates to evidence each CPAC statement.

- Ensure that candidates are engaged with Practical Endorsement and its assessment. Candidates need to have PE and its assessment explained at the beginning of the course. In addition, candidates must be clearly informed of the CPACs that are assessed in each practical session.
- Review your assessment of CPAC with colleagues. This is particularly important when new members join your teaching team. Make sure that PE is an item on the agenda of subject meetings.
- Please also remember that candidates **must** be informed if they have achieved Practical Endorsement **before** the centre submits outcomes to EDUQAS in accordance with JCQ requirements. EDUQAS will not change centre gradings if a centre has passed the monitoring visit.
- Centres are reminded to download the following document which provide support on interpreting CPAC: ['The Practical Endorsement Standard'](#).



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