GCE EXAMINERS' REPORTS

WJEC EDUQAS AS CHEMISTRY

SUMMER 2016

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CHEMISTRY

AS

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COMPONENT 1 – THE LANGUAGE OF CHEMISTRY, STRUCTURE OF MATTER AND SIMPLE REACTIONS

General

Perhaps since this was the first occasion on which this paper had been taken by candidates, there were clearly some questions that proved challenging. Examples where difficulties were apparently encountered will be discussed in the comments on individual questions. However it was evident that, in general, candidates had been well prepared and all questions produced some answers that showed real understanding of the chemical principles involved. This meant that able candidates achieved high marks and even the weakest candidates gained some of the marking points. In order to score high marks it is necessary to answer the question precisely by really reading exactly what the question is asking.

The new specification has greater emphasis on the demonstration of mathematical and practical skills. In general, candidates showed good mathematical skills and also good awareness of some aspects of the practical techniques that they would have seen during their course. However some responses to questions based on practical situations lacked the detail necessary at AS.

Section A

1. Most candidates could write an electronic structure with only a few incorrect responses being seen. These generally quoted $3d^5$ or the use of 4d.

2. Since the question required candidates to show 'the *formation* of sodium sulfide' diagrams before and after electron transfer were required. Most candidates showed this correctly and gave the correct charges on the resulting ions.

3. Most candidates were able to balance the decay equation correctly.

4. The mark was not credited when candidates quoted only the change in oxidation state that showed oxidation or that which showed reduction.

5. Most candidates knew that 1 mol was in some way involved and most gave acceptable responses.

6. Since the question asked that the shape of a 2p orbital be shown, responses that showed more than one were not accepted. Any orientation with respect to the axes was acceptable.

7. Most candidates were clearly aware of the significance of the term *atom economy* so that, apart from errors in calculating *M*r values or confusion about which value was the numerator and which the denominator, answers were generally correct.

8. Some answers that recognised that electronegativity was in some way involved in polarity did not discuss the reason for the polarity but instead considered the identity of possible atoms or the effects of the polarity on the properties of the resulting compound.

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Section B

9. *(a)* Most candidates stated that it was the mass of one atom and that ^{12}C was the reference. Some answers lacked precision since, for full credit, it was necessary to state that the comparison was with one atom of ^{12}C.

(b) (i) Nearly all candidates labelled the magnet in the mass spectrometer correctly.

(ii) Most also knew that electrons were involved in the region labelled **A** with some failing to explain that electrons were both the particles fired by the gun and those knocked off the atom.

(c) Many correct answers were seen. A few candidates misread the graph so that the relative abundances did not add to 100 % whilst others did not give an answer correct to three significant figures.

(d) This proved the most challenging part of the question. Most candidates drew a line at m/z 81 and some also drew lines at 158, 160 and 162. Only the most able however recognised the relationship between the heights of these latter three lines.

10. *(a)* Credit was awarded for diagrams showing the arrangements of the ions or for naming these arrangements. More candidates drew acceptable diagrams than actually named the arrangement. Many quoted co-ordination numbers but few explained the reason for this difference.

(b) Most candidates recognised that the difference in state was due, in some way, to the strength of hydrogen bonds compared with van der Waals forces. However many answers did not make it clear that, in order to change state from liquid to gas, it is **intermolecular** forces/bonds that need to be broken.

(c) Credit could again be gained from diagrams or the name of the shape of each ion (but these could not contradict each other). Although some correct diagrams/names were seen, it was disappointing to note how many incorrect bond angles were given and how few candidates mentioned the number of bond pairs and the significance of the repulsion between them.

11. This question was designed to allow candidates to show their familiarity with the practical tests involved in qualitative analysis. Although some good answers were seen, many candidates left significant gaps or did not appear to understand the use of or significance of the tests involved.

(a) Few correctly identified **X** and **Y**. Many answers involved Group 1 metals or apparently random Group 2 metals. If the correct identities were given, generally an acceptable explanation followed.

(b) In parts (i) and (ii) candidates were told to use **X** and **Y** in their equations but answers that followed from *(a)* were accepted. It was disappointing to note errors in the charges on the sulfate and hydroxide ions and also incorrect state symbols being used.

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(c) (i) This question included precise instructions telling candidates what they should include in their answers. Some followed these and gained credit but others apparently ignored them and omitted significant much information. Candidates must be careful in their use of names of species i.e. bromine/halogen is not the same as bromide/halide.

(ii) Most candidates who realised that halides were involved gave the test with silver nitrate. For full credit it was necessary to include the colour of the precipitate and details of its solubility/insolubility in ammonia.

12. *(a)* Although many candidates clearly knew the chemical principles involved in the production of a yellow flame by sodium, to gain the highest marks they were required to actually discuss the statements made. Most candidates recognised that electrons, rather than atoms, were involved and that the spectrum was due to energy emission. Fewer commented on the statement that only one line was present in the spectrum or why the colour seen was yellow.

(b) This question covered directly a practical procedure with which candidates should be familiar. Most did describe a flame test but a significant number did not state that the flame used should be blue. A number either omitted details of the flame colours associated with the metal ions or gave incorrect colours. The most common error was to describe a bright white flame for magnesium ions.

(c) (i) It appeared that most candidates knew the expression E = hf but a number were not able to use the wavelength given to calculate the frequency.

(ii) Most candidates correctly gave the ultraviolet region.

13. (*a*) (i) Most candidates gave a correct equation with only a few errors seen. H_2CO_3 is not an acceptable alternative to CO_2 and H_2O.

(ii) This section is also directly based on quantitative exercises that all candidates would be expected to have practised.

I Many responses lacked the necessary detail. If, in a question, words or phrases are shown in bold, candidates must take note and respond appropriately. In this case the use of bold for **masses** and **volumes** suggested that suitable values should be quoted/calculated. Some candidates suggested the use of suitably sized volumetric flasks but few realised that 0.05 mol dm^{-3} sodium carbonate was needed. This meant that only the most able candidates actually calculated the mass of sodium carbonate that should be dissolved.

II Better responses were seen here. It was apparent that candidates were familiar with the apparatus and techniques used in titration. This was very pleasing given the additional emphasis on practical work at the heart of the new specification.

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(b) Most candidates correctly calculated the pH.

(c) (i) Most candidates recognised that the filtered precipitate should be washed and dried but few explained why. This is another example where marks were apparently lost when candidates failed to read the question carefully enough.

(ii) Many candidates seemed to find ionic equations and/or the associated state symbols difficult.

(iii) Although some correct and well explained calculations were seen, a number of candidates merely used the two numbers given in the question to calculate a percentage.

14. *(a)* The expression for K_c was generally known.

(b) Although some candidates seemed to use rather odd methods to reach an answer, many were able to deduce the number of moles of ethanoic acid.

(c) Even when a correct expression for K_c was given in part *(a),* some candidates did not seem to understand its significance when using actual data. It was apparent that some candidates did not realise that the number of moles of ester and water must be the same.

(d) It was not acceptable to suggest that errors had been made by the student. An answer based on the time needed for the equilibrium to be established was required.

(e) Many candidates did recognise that reflux is a suitable method to allow heating for the one hour specified in the stem of the question, without significant loss of reagents/ products.

(f) (i) Only the most able candidates gave a correct answer. Answers based on the effect on the equilibrium of adding water or of removing acid were accepted.

(ii) Although few candidates gained marks in part (i), more used their answers to predict an effect on the value of K_c that followed their conclusion. This was worthy of credit.

(g) Many candidates were able to use le Chatelier's principle to deduce the nature of the forward reaction.

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CHEMISTRY

AS

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COMPONENT 2 – ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

General

This was the first examination of this unit for the new GCE specification, and the examiners designed the paper with a new 'flavour' to reflect the most recent changes. This examination contains less mathematical material and more 'clear learning' than Component 1. Some candidates did not learn the material adequately; their responses consequently lacked detail and were often poorly expressed. A significant number of candidates failed to gain 25 % of the available marks and only a few candidates gained over 75 %.

The highest mark was 64 and the lowest 12. Section A proved to be very accessible for the majority of candidates. In Section B the most successfully answered question as a whole was question 9. The easiest parts on the entire paper proved to be 8*(a)*, 2 and 4*(a)*, while the hardest parts were 7*(e)*, 6*(a)*(ii) and 8*(e)* in that order.

It was good to see that almost all were very knowledgeable in analysing spectral data. Another strong area was the experimental determination of an enthalpy change of reaction (in this case enthalpy change of solution). It was also pleasing to note that a significant number of candidates performed well in the calculation questions.

It was however noticeable that a large number of marks were lost because candidates did not read the questions carefully enough and did not give specific answers to the actual question. This was particularly true in question 6*(a)*(iii) [using experimental data to determine the structure of an alcohol] and question 7*(a)* [difference in alkane and alkene halogenation]. It appears that, on occasions, candidates see a particular word and base their answer on what they know about that word rather than carefully reading what is required.

Section A

This was the most successfully answered section in the paper, with the mean mark being just over 6 out of 10.

1. Both parts proved to be a fairly positive start to the paper. Over 60 % of the candidates drew a correct skeletal formula and a displayed formula for the straight-chained isomer.

2. Well answered. The vast majority could write an equation for the combustion of butane.

3. Less than half the candidates could give an example of an electrophile. A number gave the formula of a compound without showing a positive or partially positive charge and so did not get the mark.

4. Part *(a)* was well answered with the vast majority gaining the mark for the distribution curve. In part *(b)* a significant number omitted 'minimum', which was essential to gain the mark.

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5. Parts *(a)* and *(c)* were well answered with the vast majority knowing a catalyst used in the conversion of alkenes to alkanes and a test for alkenes. However, part (b) was less well answered with only around 40 % knowing why this conversion is important.

Section B

6. *(a)* (i) Poorly answered. Just under half could identify **B** as butanal but only about one candidate in six could identify **C** as butyl ethanoate.

(ii) Very poorly answered. Although many candidates knew that **D** was an acid, only a few correctly identified **E** as the sodium salt of the acid.

(iii) Again very poorly answered. Just over 40 % managed to score 2 out of 5. Almost all candidates agreed with the statement since an acid was formed. Most did not consider all the possible alcohols and so they could not explain why the statement was incorrect.

(iv) Most candidates struggled to produce a diagram based on a practical procedure. To gain credit it was necessary to draw a suitable vessel in which to carry out the reaction, a condenser with correct water connections and a thermometer with bulb opposite the condenser outlet. The examiners accepted any shape flask for the reaction vessel and were lenient with the drawing of a condenser. Many of the diagrams were very poor and those who knew what a condenser was had little idea of how it fitted to the flask.

(b) (i) The vast majority knew that this was a nucleophilic substitution reaction. Most candidates were clearly familiar with curly arrow mechanisms but marks were not awarded if arrows started and finished inappropriately. Candidates should be aware that, for example, that if a bond is being broken the arrow must start on the bond. A significant number scored at least 3 out of 4 marks.

(ii) Most candidates are clearly competent in using IR spectra, however a significant minority only referred to either the wavenumber or bond and so lost a mark.

(iii) About two-thirds realised that the C–I bond is weaker than the C–Cl bond and so the reaction is faster.

7. *(a)* In this six mark question, candidates had to outline and explain the difference in how alkanes and alkenes react with halogens. This was poorly answered with the majority scoring in the lower band. The majority named the reaction types but only a few attempted to explain the difference in ease of halogenation in terms of the bonding in the hydrocarbons.

(b) Few scored all 3 marks because they failed to heat the sodium hydroxide. The majority remembered to add nitric acid and gained 2 marks. Almost all added silver nitrate and gave the expected result.

(c) Part (i) was fairly well answered. Around 40 % knew that the product of the elimination reaction was but-1-ene. In part (ii) over half knew the conditions for the reaction.

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(d) Well answered. Most candidates could explain boiling temperature in terms of intermolecular bonding.

(e) Very poorly answered. Candidates did not seem to understand what was meant by 'properties' of HFCs. The vast majority simply stated that they should not form radicals or gave uses.

(f) Most candidates used the information to find the structural formula of the CFC. Almost all gave the correct empirical formula and many correctly interpreted the NMR data. Only the better ones explained the significance of the mass spectrum data.

8. *(a)* The best answered part of the paper. The points were usually plotted correctly and a suitable best fit line drawn. The main error was in the labelling of the axes.

(b) Only about 40 % of candidates managed to obtain both marks. Some did not realise that the y-axis was 1/time rather than time, but the main error was a failure to realise that the values had been multiplied by 1000.

(c) Well answered. Measuring the volume of gas formed over time was the most popular answer.

(d) This mole calculation was well done with over two-thirds scoring both marks.

(e) Poorly answered. Only a few candidates could calculate the volumes of thiosulfate and water needed. A minority correctly identified that a burette was used.

(f) Many candidates found it difficult to explain why the total volume was the same in all experiments. Although the experiment was about the effect of changing the concentration of thiosulfate, many stated that it was 'to ensure there was the same concentration of reactants in all the experiments'.

(g) Again answers were not specific enough. Many candidates knew that there would be some residual chemicals in the flask and that these would affect the next experiment, however they did not specify what these chemicals would be or how they might affect the next experiment.

(h) About half realised that the time taken would increase since there would be a smaller depth of liquid.

9. This was the most successfully answered question in this section.

(a) (i) Although the vast majority managed to score at least 1 mark, only about 40 % used the data correctly to score the full 4 marks in this practical enthalpy calculation. The main errors were giving a negative sign (despite it being an endothermic reaction) and incorrectly calculating the number of moles of ammonium nitrate.

(ii) Most candidates managed to get the insulation mark and explanation, but only a few could give another improvement.

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(iii) About three-quarters realised that 1 g of water was the same as 1 cm^3 of water, but only half of these scored the second mark by stating that a burette or pipette should be used.

(b) The first two parts were calculations to find an enthalpy change of reaction and both were well answered. In the first part about three-quarters correctly used enthalpy change of formation values while in the second about two-thirds correctly used average bond enthalpy values. In the final part, again about two-thirds could explain which calculation would give the more accurate value.

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