# GCE EXAMINERS' REPORTS

## CHEMISTRY (Legacy)
## AS/Advanced

## SUMMER 2009

**Statistical Information**

This booklet contains summary details for each unit number entered; maximum mark available; mean mark achieved; grade ranges. *N.B. These refer to 'raw marks' used in the initial assessment, rather than to the uniform marks reported when results are issued.*

***Annual Statistical Report***

The annual *Statistical Report* (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

**CHEMISTRY**

**General Certificate of Education 2009**

**Advanced Subsidiary**

*Examiner:* M. E. Anthoney Ph.D.

**Unit Statistics**

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH1 | 412 | 66 | 41.0 |

**Grade Ranges**

| | |
|---|---|
| A | 46 |
| B | 40 |
| C | 35 |
| D | 30 |
| E | 25 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH1

### General Comments

As a paper set solely to enable candidates to complete the outgoing syllabus, this CH1 attracted a small entry of only 412 candidates, almost all of whom were repeating the module. 52 candidates sat through the medium of Welsh.

Nearly all the candidates were second year A level students at the end of their course who received extra training from doing the CH5 unit which has several topic areas in common with CH1. The experienced nature of the candidates showed in that almost all answered the complete paper, with very few blank spaces where parts of questions were omitted. A good number of students did very well. The mean mark was 41.0, higher than those for recent June CH1 papers because of the one-off experienced cohort of candidates. The highest mark was 62 (out of 66 maximum) and the lowest 12.

Section A was well answered, with a larger than usual proportion of candidates scoring full marks. Section B was more of a mixed bag, with the worst answers to be found in the questions on ionisation energy (8a and b) and mole and gas calculations (9b). A surprising number of candidates made a mess of the dot and cross diagrams of question 10b, normally regarded as one of the easier topics.

### Detailed Comments

### Section A

The most common errors were:

Q.4 A significant number put tetrahedral or trigonal bipyramidal as the shape of $BF_3$ instead of trigonal (planar).

Q.5 As usual, very few candidates could cope with mole calculations, however straightforward.

Q.7 Very few succinct answers were encountered, with many scripts containing answers overflowing untidily from the allowed space, making marking difficult. The commonest error was a failure to make clear the intermolecular nature of hydrogen bonding.

### Section B

Q.8 (a) Well done by only the stronger candidates, with evidence of guessing by many weaker candidates.

(b) This was quite poorly answered overall. Although many mentioned extra shielding, very few gave the correct electronic structure to explain the difference. Quite a few tried to explain by saying that the electronic structure of H was stable but did not go on to fully compare this with element.

(c) Most errors derived from using an incorrect number of electrons.

(d) The radioactivity questions were well answered in most cases.

Q.9 (a) A surprising number of candidates struggled with (a) (ii), some trying to work out an average of the two masses. Part (a) (iii) rarely scored full marks, with many people forgetting to put a positive charge on the molecular ion or putting a positive on each of the Cl atoms. Almost everyone recognised the isotopes which made up each peak.

(b) There were quite a lot of correct answers to (i) and the first two parts of (ii) but only the very best candidates managed to correctly identify the element X and the formula $PCl_3$.

(c) Disappointing answers in general: many candidates discussed reactivity or electronegativity and very few talked about intermolecular van der Waals' forces.

Q.10 (a) There were few problems apart from a number of answers in (i) giving names instead of the requested formulae and some of the weaker candidates using random selection for the chloride which produces a neutral solution.

(b) Most knew that electronegativity was to do with attracting electrons but many forgot to mention that it had to occur within a (covalent) bond. As already mentioned, there were a surprising number of mistakes in the dot cross diagrams, including drawing MgO as covalent, omitting the ion charges, showing 2 electrons around Mg but 8 around $Mg^{2+}$ and omitting the non-bonding pairs on the Cl atoms in $SiCl_4$.

(c) Most candidates managed to score 2 or more marks on this part. Many obtained these through a correct (but often unnecessarily scruffy) diagram and relatively few used the term body-centred cubic in their description. Too many candidates put 8 as the co-ordination number instead of 8:8, but it was generally well known that Cs is larger than Na.

Q.11 (a) A pleasing number of candidates correctly calculated the formula as $CaSO_4.2H_2O$.

(b) Most candidates gained the flame test mark for calcium. Red is not acceptable as the colour of a calcium flame, and precipitation of carbonate is not an acceptable test for calcium ions in solution. Part (ii) caused more problems with candidates giving an incorrect equation for the reaction with sodium hydroxide, although they were aware of there being a white precipitate. Many also thought there would be a white precipitate for the reaction with sodium hydrogen carbonate.

When calculating the concentration of the saturated solution, almost everyone who made an error here did so by using 136.2 for the molar mass instead of 172.2.

In part (iv), many tried to use the equation n= m/Mr and thought the number of moles would be less as Mr was higher for barium sulphate. Those who thought about the trend in solubility still not infrequently managed to get the wrong answer.

(c) Part (i) was answered quite well but a common mistake was to have CaO as a product.

In (ii) most candidates made a reasonable attempt at an answer. Several wrote +2 for the oxidation state of H in water but those who had the correct equation in (i) normally achieved full marks.

**CHEMISTRY**

**General Certificate of Education 2009**

**Advanced Subsidiary**

*Chief Examiner:* D.H.Ballard, B.Sc., Ph.D., C.Chem., F.R.S.C.
formerly Senior Lecturer in Science Education, Nottingham Trent University.

**Unit Statistics**

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

| **Unit** | **Entry** | **Max Mark** | **Mean Mark** |
|---|---|---|---|
| CH2 | 397 | 66 | 40.7 |

**Grade Ranges**

| | |
|---|---|
| A | 47 |
| B | 41 |
| C | 36 |
| D | 31 |
| E | 26 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH2

### General Comments

This was the last paper for this legacy specification and was taken almost exclusively by candidates retaking this module. There were some very good scripts but, surprisingly, the examiners saw a number of papers where the score was less than 20 out of 66.

As in a number of previous examinations, some candidates did not read the questions carefully enough, and wrote what they knew about the topic rather than responding to the question.

The examiners felt that the calculations in this paper were generally handled with confidence; however some candidates muddled up plus and minus signs in $\Delta H$ calculations.

### Section A

Q.1 (a) The correct name for the compound was 2-bromo-3-methylbutane. The examiners allowed the numbers the other way around and most candidates obtained a mark for one or the other.

(b) Almost all candidates recognised the type of reaction as elimination.

Q.2 Although many candidates correctly indicated $E_f$ and $\Delta H$ on the diagram, there were those who wrote the letters without arrows, leaving the examiners with no clues as to what they meant.

Q.3 (a) The question asked for an observation. Some candidates still persisted in writing vague statements such as 'a gas is given off', which does not constitute an observation. However, the identification was usually correct.

Q.4 Very few candidates achieved two marks for this question. Many candidates did not use the information in the table to respond to the question. The examiners were looking for a comment about the stability of the two oxides as indicated by the $\Delta H_f^\theta$ values provided. This was seldom done; the more usual response was about one of the oxides being more exothermic than the other.

Q.5 Most candidates recognised that propanoic acid was the most soluble in water from the list given.

Q.6 The examiners were looking for an increase in the intensity of light but this was not always given. Other answers included the use of a catalyst or in some way increasing the 'concentration' of silver bromide.

**Section B**

Q.7 (a) (i) The question asked for methene and chlorine as reactants and chloromethene as the product. A number of mechanistic equations were given which did not include these reactants and products.

(ii) A number of candidates wrongly used the word 'molecule' when identifying a replacement species in substitution.

(iii) The initiation stage of the free radical substitution reaction was well known.

(iv) Most candidates gave a satisfactory explanation for the further reaction to give dichloromethene. Some however, used hydrogen atoms.

(v) This was the weakest part of the question. Relatively few candidates could explain how hexane could be a product from the reaction of propane with chlorine. It was common to award the second mark but not the first mark. Some candidates referred to propane free radicals rather than propyl free radicals.

(b) Butane and its formula were identified by most candidates.

(c) (i) The question asked candidates to complete the mechanism for the reaction of propene with hydrogen bromide. A sizeable number of responses showed curly arrows from atom to atom. The examiners continue to feel that the drawing of correct and precise mechanisms is a weak area.

(ii) A number of candidates could not state that the relatively greater stability of the secondary 2-propyl carbocation was a reason why 2-bromopropane was the main reaction product. It was common to see statements such as '2-bromopropane is more stable than 1-bromopropane'.

(d) Most candidates managed one mark here for the addition of silver nitrate, resulting in a white precipitate. Often there was no mention of the need for initially adding sodium hydroxide and then acidifying the products. Some candidates added the acid before the alkali.

Q.8 (a) (i) The term 'homogeneous 'was well understood.

(ii) Only a few candidates are still not using square brackets to represent concentration in $K_c$ expressions.

(iii) Sadly, many candidates still fail to recognise that the value of the equilibrium constant is only altered by a change in temperature, not by a change in pressure.

(iv) The application of le Chatelier's principle was used correctly by a number of candidates. Some neglected to state that the reverse reaction was endothermic and lost one of the two marks.

(b) (i) Many candidates merely said that the number of collisions increased. It is the increase in the **rate** of successful collisions which is important**.** It was more common to allocate only one mark here.

(ii) A lack of practical experience in the method of sampling in kinetics reactions lead to candidates losing marks. Some suggested a suitable sampling technique but could not then continue their answer.

(iii) Although many candidates gained some of the marks; errors such as dividing rather than multiplying and the incorrect use of mole ratios resulted in a wrong answer. Some extremely weak (and strong) vinegar is apparently being sold!

(c) This was a two mark question and it was unusual to see candidates gaining both marks. The examiners were looking for a statement about the hydrogen ion concentration and this was too often missing.

Q.9 (a) (i) The environmental problems associated with carbon dioxide and sulphur dioxide were well recognised by most candidates. However, a number of candidates continue to associate carbon dioxide with ozone depreciation.

(ii) Enthalpy calculations seem to be troublesome for a sizeable minority of candidates but most candidates were able to gain at least one of the two marks available. The correct number with the wrong sign was all too common.

(b) (i) Nearly all candidates were able to describe a test for ethene, with bromine being the preferred choice.

(ii) Addition or hydration was the usual correct response to the type of reaction occurring when ethene reacted with water/steam. A number wrongly stated hydrolysis or hydrogenation. The question did not ask whether this process was electrophilic, nucleophilic or free radical and such additional responses were ignored by the examiners. The structural formula of ethanol was usually correct but a few inexplicably gave the formula of ethene.

(c) (i)&(ii) It was disappointing to see that some candidates still do not know the meaning of the terms empirical and molecular formulae.

(iii) A large majority of candidates did not notice that the question said that Compound **P** was a branched alkene, and gave but-1-ene or but-2-ene as their response instead of 2-methylpropene. The latter does not show cis-trans isomerism but part (iv) of this question was marked consequentially on the candidate's answer to (iii). There was confusion, too, in describing the lack of free rotation about a double bond.

Q.10 (a) Many candidates had difficulty with this bond energy calculation. The principal reason was that they did not realise that there were four Cl-O bonds present. As a result it was unusual to see full marks for this part.

(b) Only the more able candidates were able to spot a 3:2 ratio in the equation and give the correct answer of 2.4 mol $dm^{-3}$ $min^{-1}$ as a result.

(c) (i) This question concerned ethene and crude oil. There were many excellent answers to this question, but all too many obtained ethene directly from crude oil by fractional distillation without the need for cracking larger alkane molecules. The equation for the polymerisation of ethene sometimes lacked clarity in the use of 'n' and there were some speculative values for the temperature and pressure of the polymerisation step.

(ii) The question asked for an advantage and a disadvantage of the use of poly (ethene) in society. Many candidates simply gave uses and these did not gain credit. However, 'non-biodegradable' was a popular correct choice for a disadvantage of the use of poly (ethene).

Margaret Oliver has submitted the following comments about the performance of the candidates who took the examination through the medium of Welsh. A translation is provided beneath.

**Adroddiad CH2 Mehefin 2009**

Yn gyffredinol, roedd safon y Gymraeg ysgrifenedig yn dda ac nid oedd tystiolaeth o unrhyw ddryswch oherwydd y termau cemegol yn y Gymraeg. Roedd y cryfderau a'r gwendidau yn y papurau cyfrwng Cymraeg yn debyg iawn i'r papurau cyfrwng Saesneg. Calonogol oedd gweld, ar y cyfan, safon dda mewn atebion mathemategol a chwestiynau `organig`. Efallai o ganlyniad i'r ffaith bod mwyafrif yr ymgeiswyr yn ail sefyll y papur ac felly'n fwy profiadol yn y meysydd hyn.

Cafodd yr ymgeiswyr farciau da yn rhan A, gyda'r gwendid amlycaf yng nghwestiwn 4 efo atebion amhendant ac aneglur. Yng nghwestiwn 7 (v), cafodd nifer sylweddol o'r ymgeiswyr y marc ar gyfer y ddau radical yn ymuno â'i gilydd ond gan fethu â sôn sut roedd y radicalau yn cael eu creu. Yng nghwestiwn 8 ( c), er bod ymgeiswyr yn nodi bod asid hydroclorig yn gryfach na'r asid ethanoig, prin oedd yr atebion oedd yn sôn am <u>grynodiad</u> o $[H^+]$ ac roedd rhai atebion hyd yn oed yn cyfeirio at fondio hydrogen! Yng nghwestiwn 9 (c), dangoswyd dealltwriaeth gymysg o isomerau geometrig, efo moleciwl ac eglurhad yn gwrthddweud. Cafodd rhai ymgeiswyr anhawster gyda rhan (b) yng nghwestiwn 10, ond, ar y cyfan, roedd atebion gweddill y cwestiwn yn rhesymol.

Nid oes tystiolaeth fod ymgeiswyr heb ddigon o amser i gwblhau'r papur.

Generally the standard of written Welsh was good and there was no evidence of confusion due to chemical terms in Welsh. The strengths and weaknesses in the papers through the medium of Welsh were very similar to those in the papers through the medium of English. It was heartening to see, on the whole, a good standard in mathematical answers and organic questions. Perhaps as a result of the majority of candidates resitting the paper and so being more experienced in these areas.

Candidates achieved good marks in section A, with the most obvious weakness being in question 4 with vague and unclear language. In question 7 (v), many candidates achieved the mark for the two radicals joining together but failed to mention how they were created. In question 8 (c), although candidates stated that hydrochloric acid was a stronger acid than ethanoic acid, it was rare to have answers that then mentioned the <u>concentration</u> of $[H^+]$ and some answers even referred to hydrogen bonding! In question 9 (c), mixed understanding was shown of geometric isomers with conflicting molecule and explanation. Some candidates had difficulty with part (b) of question 10, but on the whole, the answers to the rest of the question were reasonable.

There was no evidence that candidates were without enough time to finish the paper.

## CHEMISTRY

### General Certificate of Education 2009

### Advanced Subsidiary

*Examiner:* Dr Peter Blake

**Unit Statistics**

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| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH3 | 359 | 30 | 25.4 |

**Grade Ranges**

| | |
|---|---|
| A | 24 |
| B | 22 |
| C | 20 |
| D | 18 |
| E | 16 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH3a

### General Comments

This has been the last year for this short paper based on knowledge and understanding of the theory/practical interface but, since similar questions are now likely to appear on the theory papers, it is worthwhile making comments on how the questions were dealt with. Although a legacy paper, there was a relatively large entry as candidates attempted to improve their marks. In this they were largely successful, presumably through experience of this type of question and increasing scientific maturity and many marks were in the high twenties.

Q.1 As usual the rate data was mostly accurately plotted.

(a) (i) Good curves drawn in.

(ii) Candidates were told to use their plot to calculate initial rates and not just the table; it is unsound not to use all the information available. Rates expressed in either per minute or per second were acceptable.

(b) Answers were usually sound, stopping the reaction at the measured time and reactant concentration decreasing over time.

(i)&(ii) And any continuous monitoring method in (iii). Suggestions such as " follow temperature change" and "use indicators" were not acceptable.

Q.2 (a) (i) Most candidates extrapolated correctly to obtain a good value for $\Delta T$.

(ii) There were many sign errors in applying the equation caused by not realizing that $\Delta T$ has itself a minus sign. This uncertainty about signs appears also in the coursework and all that is needed is the simple check that if T(final) is less than T(initial) then $\Delta T$ has a negative sign and vice versa.

(b) Was usually satisfactory but statements such as "operator error" and "inaccurate equipment" are not appropriate here.

Q.3 (a) Usually correctly answered.

(b) (i) Usually correctly answered. Some judgment is required in such cases but since the gap between 20.75 and 20.20 is nearly three times that between 20.20 and 20.00 the decision to reject it is fairly clear. Had the value been 20.50 the case would have been much more uncertain. It is generally a good principle in data analysis not to reject any datum unless there is good reason.

(ii) Caused problems as usual in such concentration calculations. Most candidates correctly determined the stoichiometry of the reaction, the number of moles of carbonate involved and the titration volume but obtained a value of 4.96M, forty times too large, by forgetting that only 25 $cm^3$ of carbonate was used and not 1 $dm^3$.

Q.4 Generally well done with very few errors in compound assignment but some in observations, particularly "carbon dioxide evolved" which is not an observation, the correct observation being that bubbles of gas are evolved that turn limewater milky. This type of error occurs in the theory papers and is regrettable since the candidate knows what happens but does not answer the question.

Over its life of nearly ten years it is felt that the CH3a paper has had a useful, if only partly successful, role in encouraging candidates to give some thought to the theory and reasons underlying their practical work.

## CHEMISTRY

## General Certificate of Education 2009

## Advanced Subsidiary

*Examiner:* Mr Elfed Charles

**Unit Statistics**

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| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH4 | 994 | 75 | 37.7 |

**Grade Ranges**

| | |
|---|---|
| A | 50 |
| B | 44 |
| C | 38 |
| D | 32 |
| E | 27 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH4

### General Comments

This was the final full operational CH4 paper of the present specification. About half the candidates were resitting the paper. There was a good spread of marks, a number of scripts were very poor, with about 6% of the candidates getting 15 marks or less out of a total of 75, but fewer were outstanding. This was probably due to the majority of excellent candidates having successfully sat the paper in January.

The highest mark was 74 and the lowest 0. The most successfully answered question as a whole was Q.4 with Q.2 being the least successfully answered. The easiest parts on the entire paper proved to be Q.5 (a) (iii), Q.1 (b) and Q.5 (c) (i), while the hardest parts were Q.2 (b) (iii), Q.2 (b) (iv) and Q.3 (a) (i) in that order.

Areas which seemed strong were application of spectroscopy and practical information as an aid to structure elucidation, geometric and optical isomers and tests for functional groups.

Areas which seemed weak were repeating structures in polymers, separation of organic liquids, nitrogen chemistry and naming specific reactants. There was also a lack of precision in drawing fully graphic formulae with the bonding atoms in the correct order.

Finally, the questions involving comparisons between compounds still need to be given some attention. A number of strong candidates were explaining the basicity of the aromatic amine but not mentioning the aliphatic amine Q.2 (a) (ii)) or were writing about one polymer without mentioning the other type Q.3 (b) (ii)) and these omissions resulted in the loss of important marks.

### Papur Arholiad Cymraeg

Atebwyd tua 9% o'r holl sgriptiau trwy'r gyfrwng Cymraeg. Roedd ystod y marciau yn weddol debyg yn y papurau cyfrwng Cymraeg a'r Saesneg. Fel yn y papurau cyfrwng Saesneg dim ond lleiafrif o'r ymgeiswyr oedd yn deall y gwahaniaeth rhwng adwaith aminau aliffatig ac aminau aromatig gydag asid nitrus ar wahanol dymheredd (2) (a) (iii)) ac roedd y prosesau o wahanu a phuro cynhyrchion (3 (b) (iv)) hefyd yn anghyfarwydd i'r mwyafrif. Nid oedd diffygion mawr yn ansawdd yr iaith ac roedd y rhan fwyaf yn defnyddio termau Cymraeg cywir wrth lunio atebion. Roedd safon y goreuon yn dda iawn ond mae llawer o fyfyrwyr yn colli marciau trwy flerwch neu eu bod heb ddeall egwyddorion yn ddigon trylwyr.

### Section A

Q.1 (a) Only about a quarter of candidates gave the correct repeating unit. The $CH_3$ was often omitted and many candidates had a C = C double bond in the structure.

(b) About two thirds gained both marks and the vast majority of candidates gained a mark. The main errors were to state clear instead of colourless or a failure to give the original colour of the bromine.

(c) (i) The electrophilic addition mechanism was fairly well done with about two thirds gaining at least 2 marks out of 4.

(ii) Poorly answered. Only about a quarter gave the correct explanation in terms of carbocation stability. Many answers simply referred to Markownikoff's rule.

(d) About 2 in 5 candidates gave KOH as the correct reagent but only about half of these could also give the correct conditions.

(e) The majority knew that the formation of propene from propan-1-ol is dehydration or an elimination reaction and most also knew the reagent required for this transformation.

Q.2 This was the least successfully answered question on the paper.

(a) (i) Fairly well done but too many lost the mark by not drawing the bonds between the nitrogen and hydrogen's despite the question stating full structural formula.

(ii) Disappointingly answered because many candidates explained the answer with respect to phenylamine only.

(iii) This part was about the reaction of amines and was poorly answered. A few candidates lost marks by giving names instead of formulae but many blank answers were seen. It appears that this section of the specification is not well understood.

(iv) This part was about the formation of an azo dye and about 2 in 5 candidates gave the correct structure. The main error was to include a triple bond between the nitrogen's.

(b) Parts (i) to (iii) were about the bromination of benzene.

(i) Candidates had to give the formula of the reacting species and only about a quarter could successfully do this. $Br_2$ was the most popular incorrect answer. About half could correctly name a suitable catalyst.

(ii)&(iii) Only about 1 in 6 candidates could explain the catalyst's role in the reaction.

(iv) Was about the purification of a liquid product and again it was poorly answered. The vast majority ignored the fact that the product was a liquid and purified by filtering then recrystallising and drying to constant mass.

Q.3 (a) (i) Surprisingly only about 1 in 5 could correctly name the aldehyde. Many candidates did not use the longest chain and 2-ethyl butanal and 3-ethyl butanal were common answers.

(ii) This question was about naming geometric and optical isomers and many candidates scored full marks.

(iii) This part required candidates to choose isomers of ethyl ethanoate and was fairly well answered with about three quarters gaining at least 1 out of 2. Poorer candidates obviously did not know the structure of ethyl ethanoate and consequently gained no marks.

(iv) Only about a quarter could give a different isomer. Many candidates repeated structures already given in the question.

(b) (i) Well answered with over half giving the correct monomers. Marks were sometimes lost because of carelessly drawn structures with the OH the wrong way round or by failing to realise that an OH was required at both ends of the molecule.

(ii) Very well answered generally. However a significant number lost some marks by not making a comparison and only referring to one type of polymer.

**Section B**

**Q.4** This was the most successfully answered question on the paper.

(a) (i) This question was generally very well answered with over half the candidates gaining at least 7 marks out of 9. However marks were lost because not all the information was used. Most candidates used the analysis to obtain the correct empirical formula, but some failed to link it with the molecular ion peak in order to give the molecular formula. The reactions and the infrared values were correctly interpreted to give the acid group.

Some candidates did not use the information about optical isomerism. The use of the NMR analysis was the least well done part of the question. Many candidates simply used the chemical shift data without taking into account the peak area data and the splitting data was often ignored.

(ii) Generally well answered. The vast majority scored at least 1 mark out of 2. The main error was to omit **heating** with sodium hydroxide.

(iii) Very well answered. Almost all candidates knew what was meant by optical isomerism and most knew how to distinguish optical isomers from each other. However some still omitted ‘plane’ from ‘plane polarised light’ and used “reflect” or “deflect” instead of ‘rotate’.

(b) (i) In this part candidates had to compare the solubility of ethanoic and hexanoic acids. Although about one third gave clear and concise answers and so gained both marks, many explanations were confused or lacked depth of content.

(ii) Poorly answered. Only about a quarter candidates could write balanced equations for reactions involving ethanoic acid.

(iii) As usual the percentage yield question polarised the candidates with about 2 in 5 scoring all 3 marks but one third failing to gain any mark. Weaker candidates simply divided 5.38 by 5.80 and multiplied by a 100 instead of converting to moles.

Q.5 (a) (i) Very well answered. Almost all candidates knew a large scale use of ethanol.

(ii) In this part candidates had to explain why the OH group acts differently in phenol and ethanol and it was poorly answered. Explanations were often confused and many referred to electrons in the OH group instead of to the lone pair on the oxygen atom. Many referred to the stability of phenol rather than the stability of the phenoxide ion, while others thought that phenol accepted a proton rather than losing it to form the phenoxide ion.

(iii) A chemical test to distinguish between phenol and ethanol was very well known. A few lost some marks by giving the correct test but only the result for phenol.

(b) The majority knew that $Na_2Cr_2O_7$ was the correct reagent to convert ethanol to ethanal. However the vast majority used reflux instead of distilling the product as it formed. The use of $KMnO_4$ was not accepted as this would lead to the formation of ethanoic acid rather than ethanal.

(c) (i) In this part the candidates had to distinguish between ethanal and propanone and it was extremely well answered. Over three quarters gained all 3 marks. The main error was giving a negative result for ethanal with iodine in aqueous sodium hydroxide. Some failed to give the observations for each compound and were penalised accordingly.

(ii) Generally well answered. Most knew how to use the 2, 4-dinitrophenylhydrazone to identify the carbonyl group. Main errors were not to compare the melting point with a known value or to measure the boiling point.

(d) About two thirds of candidates scored at least 2 marks out of 4 in describing the mechanism for the photochlorination of methane. A common mistake was to form hydrogen radical in the propagation stage.

(e) This part asked how bromoethane could be converted to propylamine and it was poorly answered. Only about 1 in 4 gained at least 3 marks out of 4 and about half the candidates failed to gain any marks. Surprisingly few candidates knew that KCN had to be used to increase the carbon chain to form the nitrile and then this had to be reduced to form the amine.

## CHEMISTRY

### General Certificate of Education 2009

### Advanced Subsidiary

*Chief Examiner:* *M. E. Anthoney Ph.D*

**Unit Statistics**

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| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH5 | 1543 | 75 | 41.7 |

**Grade Ranges**

| | |
|---|---|
| A | 53 |
| B | 47 |
| C | 42 |
| D | 37 |
| E | 32 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH5

### General Comments

There were 1543 candidates sitting this paper, of whom 118 did so through the medium of Welsh. The mean mark was 41.7 (maximum 75), compared to 40.2 last year, with standard deviation 13.2. The highest mark was 73 and the lowest 1.

There was no evidence of candidates having inadequate time to attempt all the questions. While some questions were challenging and discriminating, nearly all candidates were able to attempt most questions and there were no dead marks.

Following the trends of recent years, the thermochemistry (Q1) and kinetics (Q2) questions were handled well and candidates scored good marks. The question on acids and bases (Q3) was less well done, with explanations of buffer action often simplistic and vague. In Section B, Q4 proved a real discriminator: a good chemist knows when to state the obvious as well as when to employ more subtle arguments. A failure to do the former unnecessarily lost many candidates marks. Other traditional problems also remain such as a poor knowledge of inorganic reactions or a lack of appreciation of what constitutes a description of an observation, (e.g. "HCl is evolved"), and writing correct balanced equations seems beyond the capabilities of many. The electrochemical question (Q5) produced many encouraging answers and candidates generally scored well. The recent improvement in handling calculations continued, with very many candidates getting the redox titration correct, though a disappointing number failed to give answers to three significant figures as instructed – perhaps understandable in this case since the final significant figure was a zero. Several markers commented about the scruffy nature of candidates' diagrams in the answers to Q5, making marking very difficult. In some cases marks were lost because examiners were unable to follow what candidates had drawn.

A few candidates used coloured inks to emphasise points in their answers. This is not allowed since it interferes with the marking process.

### Detailed Comments

### Section A

Q.1 (a) Most candidates demonstrated a good understanding of the Born Haber Cycle with the commonest source of errors being the value for the atomisation of hydrogen.

(b) A surprisingly large number of wrong answers were encountered, even though marking was consequential upon the candidate's own $\Delta H_f^\ominus$ value, whether right or wrong. A number of candidates focussed on the magnitude of $\Delta H_f^\ominus$ rather than its sign.

(c) *Reducing agent* was well known, though a surprising number of candidates made no mention of electrons in their answers. Sodium hydroxide and hydrogen were usually correctly given as the products of the reaction, but the use of oxidation numbers to show that NaH acts as a reducing agent was poorly done. Two common errors were to state that "H is reduced" without specifying which hydrogen (NaH or $H_2O$) this applied to, and to allocate -1 as the oxidation number of Na in NaH.

(d) The flame test was correctly chosen by most candidates, though it should be made clear that the sodium ion does not "burn" when producing yellow / orange colour in a flame.

(e) Nearly all candidates correctly balanced the given equation, but many weaker candidates failed with the gas calculation. The use of 1kg was a particular source of problems.

Q.2 (a) *Rate determining step* was known by most candidates, though a common loss of marks was to define it as "a slow step" rather than the *slowest* (or in this case, *slower*) step. Despite the instructions, many answers were not supported by a reason.

(b) The deduction of reaction orders was done correctly by most candidates, as was the rate constant calculation in part (ii). Many good attempts were made for a possible rate determining step in (iii).

(c) A small number of candidates persist in using square brackets or omitting a symbol for partial pressure when writing out Kp, but most gave the expression correctly. A disturbing number were not able to manipulate the mathematical expression in part (ii) after having correctly substituted values. Only the better candidates applied correct reasoning to identify the reaction as endothermic in (iii).

Q.3 (a) When defining *weak* acids, *partial (or slight) dissociation into ions*, or *a low Ka value*, are more appropriate phrases than the description "not completely ionised". Ka, the acid dissociation constant, was well known.

(b) A surprising number of candidates failed to read the graphs correctly in part (i), with values often being given the wrong way around. Others displayed great optimism in precision by quoting answers to two or three decimal places. In part (ii) almost all were able to calculate $M_r$ for the acid while just a few slipped up with the salt, failing to include 3 complete molecules of water in the calculation. With the benefit of errors being carried forward, most answers to part (iii) were correct as were those to (iv). There were few correct approaches to part (v), however, with values of $[H^+]^2$ frequently being used, completely ignoring [salt] which had just been calculated!

(c) Explanations of buffer action were generally poor, often using simplistic and vague phrases such as "mops up the acid" or talking about "the equilibrium" or "the acid" without specifying the species involved.

**Section B**

Q.4 (a) As mentioned in the introduction, neglecting to state the obvious can cost marks. In discussions on bonding, an obvious starting point should be the electron configuration within atoms but this was not always considered. Other common errors included neglecting to explain adequately the meaning of "deficient" in part (i), introducing electronegativity and atomic size as unnecessary distractions into answers for part (ii) and in part (iii), though most gained marks for expansion of the octet for phosphorus, the situation for nitrogen was often ignored.

(b) This question required recall of observations and equations for reactions of NaCl and NaI. Whilst nearly all candidates were able to give at least some of the observations, correct balanced equations were rare. The question also asked about redox trends but, when this aspect was not ignored completely, there was frequent confusion between trends in the oxidising properties of *halogens* and the reducing properties of *halides*. Comments such as "chlorine is a weaker reducing agent" were all too common.

Q.4 (c) The term *amphoteric* was known by nearly all candidates but, though some were able to write equations for the reaction of $Al_2O_3$ with acid, correct equations for the reaction with alkali to form aluminate were very rare indeed.

Q.5 (a) The EMF calculation was well done, with very few candidates getting the sign wrong due to reversing the electrodes and even fewer miscalculating the value. In part (ii) most presented platinum as inert but few recognised the need for a solid electrode in a mixed aqueous solution of ions.

Almost everyone gained some credit for the labelled diagram in part (iii) though full marks were only rarely awarded. There were often errors of omission despite clear guidelines within the question, and as previously mentioned the unduly scruffy nature of many diagrams did not help. The colour changes were correctly stated by many candidates, though some stated a colour change without specifying the electrode involved and others gave a single colour instead of a colour change.

In part (v) the large number of candidates failing to quote their answer to three significant figures, as instructed, took the edge off an otherwise encouraging standard of answers. A pleasing number of candidates also correctly worked out the concentration of $Fe^{3+}$.

(b) A disappointingly large number of incorrect answers. The atypical ($3d^5\ 4s^1$) Cr configuration was not well known nor was the loss of electrons from 4s prior to 3d during the formation of the ion. Those who correctly gave the Cr configuration did not necessarily succeed with the $Cr^{3+}$ configuration and vice-versa.

(c) The origin of colour in complexes by d-orbital splitting seems to be well known and there were many good answers to this question.

(d) Overwhelmingly, candidates chose the role of iron in haemoglobin for oxygen transport as their example of a trace element in living systems. Vague responses such as “iron in the blood” did not gain credit nor did the suggestions of uses of transition metals in the context of industrial engineering!

## CHEMISTRY

### General Certificate of Education 2009

### Advanced Subsidiary

*Chief Examiner:* D.H.Ballard, B.Sc., Ph.D., C.Chem. F.R.S.C.
Formerly Senior Lecturer in Science Education, Nottingham Trent University.

**Unit Statistics**

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH6a | 1533 | 50 | 28.4 |

**Grade Ranges**

| | |
|---|---|
| A | 36 |
| B | 33 |
| C | 30 |
| D | 27 |
| E | 24 |

*N.B. The marks given above are raw marks and not uniform marks.*

# CH6a

## General Comments

This synoptic paper produced a very wide response with some candidates scoring only in single figures whereas a number of scripts were seen where the marks exceeded 40 out of 50.

It is difficult to cover adequately all of the specification and, of necessity; some topics can only be covered briefly or not at all. In general the calculations were done quite well and fewer answers were seen where the answer obtained was obviously wrong.

One weaker area is the response to questions about intermolecular bonding. Many scripts were seen where it was obvious that candidates knew something about the topic but all too often the answers were confused and were not comparative.

Question 4 (b), which was about the NMR spectrum of pentan-1, 3-dione carried three marks but many candidates found it difficult to express themselves clearly enough to gain more than half marks.

## Section A

Q.1 (a) Although the equation was often correct, a number of candidates failed to give the correct states.

(b) To obtain the correct answer to this calculation, candidates had to use the correct relative molecular mass of calcium hydroxide. A number of candidates failed to calculate this value correctly or used the relative molecular mass of other compounds.

(c) Many candidates picked up both marks but some gave answers related to the rate of dissociation of hydrochloric acid into hydrogen ions, which was not acceptable.

(d) (i) Most candidates gained the first half mark but missed out on the second half mark by not relating the number of successful collisions with time.

(ii) This was an easy mark for nearly all candidates who realised that silver chloride was formed and that this is a white solid.

(e) (i) This question asked candidates to use their knowledge of the physical properties of diamond to deduce some physical properties of silica. A number of candidates thought that molten silica was an electrical conductor, despite the question stating that it was covalently bonded.

(ii) When deducing the shape of the silane molecule, many candidates failed to mention that the position of minimum repulsion was adopted.

(iii) When silane is burnt in oxygen, water is one of the products. There were many incorrect equations showing the formation of hydrogen rather than water.

**Section B**

Q.2 (a) Most candidates recognised that +3 was the oxidation state of chromium in the ore chromite, and most dropped marks here were for stating 3+ or +6.

(b) Many correct answers were seen. Some candidates failed to use the mole ratio correctly and gave 810 kg or 3240 kg and only gained partial credit.

(c) (i) The reason why crystals of potassium dichromate appeared was because of the reduction in solubility at a lower temperature. Many candidates failed to give an answer that implied this idea.

(ii) The crystals were washed to remove traces of **soluble** impurities. This was seldom seen.

(d) (i) The response 'ethanediol' did not gain a mark as the positions of the hydroxyl groups were required. Water was the correct answer and was generally given.

(ii) Many correct answers were seen but some candidates drew the formula with the OH group bonded to the wrong carbon atom. Some candidates are still not clearly showing the bond from carbon leading to the oxygen atom of the OH group.

(e) (i) The test for the presence of a carboxylic acid group was well understood.

(ii) There were a number of acceptable answers to detect an aldehyde group in phenylethanal and it was rare to read an incorrect response.

(f) Many correct answers were seen but some candidates thought that sodium chloride was covalently bonded and gave sodium hydroxide and hydrochloric acid when added to water. A few candidates attempted the hydrolysis of chromium (VI) dichloride dioxide, described in the article, but the equation for this was beyond most of them.

(g) There were many correct answers that used the given standard electrode potentials.

(h) Many candidates found it difficult to express their ideas about intermolecular bonding in a clear way. The question required candidates to give a comparative response about the forces between molecules of the each of the two compounds. This was not always done. Candidates should make it clear that their answer refers to intermolecular forces. References to covalent bonds are clearly wrong and statements about ionic bonding showed a lack of reading from the question stem.

**Section C**

Q.3 (a) (i) Nearly all candidates correctly identified the chiral centre in 'dopa'.

(ii) The test for a phenol was well known and most correct answers showed the use of iron (III) chloride. A few candidates stated that a purple precipitate rather than a solution was formed.

(iii) Some drew the zwitterion rather than the anion of the amino acid.

(iv) The structure of the peptide linkage was well known but sometimes bonds were missing.

(v) Many candidates confused homogeneous and heterogeneous catalysis. The commonest correct answer used sulphuric acid in esterification.

(b) (i) The definition of a co-ordinate bond was not always given clearly, with some candidates not really implying that it was a type of covalent bonding. Some of the examples given lacked the correct number of 'dots' and 'crosses' as required by the question. The ammonium ion and the dimer of aluminium chloride were the commonest choices.

(ii) There were many correct calculations seen. Some candidates used excessive truncation of the figures early in the calculation and this was penalised.

Q.4 (a) A few candidates continue to state that potassium iodide and potassium hydroxide are the reagents used in the iodoform test. Some still believe that the starting reagent is iodoform itself.

(b) Candidates were presented with a simplified NMR spectrum of pentan-1, 3-Dione and asked to explain how the spectrum was related to the formula of the compound. Many candidates scored some marks but a really concise explanation was uncommon.

(c) (i) This mole calculation with two steps proved to be challenging and is an area that requires attention by some candidates. It was common to see responses that did not use both the complex and 'alum' in the working.

(ii) The examiners did not believe that 'burning' was a correct description of a flame test, but nearly all candidates stated that potassium gave a purple/lilac colour to the flame.

(iii) This simple question on radioactivity proved challenging for some who had met it at the beginning of the course and not since.

(d) (i) The term 'chromophore' was well known.

(ii) Many good answers were seen. Only a few candidates muddled their answers by stating that the colour was produced by electron relaxation and the consequent emission of energy as yellow light.

(iii) Although many candidates picked up the mark here, some could not substantiate their answer by stating how their choice was done practically. Some confused an unpaired electron with 'lone electrons', 'pairs of unpaired electrons' and 'lone pairs, when asked to describe what was meant by a free radical.

Philip Hains has written the following comments about the work of candidates taking the examination through the medium of Welsh.

There were several papers with high marks and only a few with very low marks, showing that the majority of candidates had responded well to the paper. The featurers that stood out as needing attention were the generally poor response to Q.2 (f) involving electronegativity and intermolecular bonding. The concepts are not well understood. The details of NMR are also poorly understood - Q.4 (b) - while a worryingly/surprisingly large number of candidates were unable to work out the correct answer for the loss of a β particle from an iotope of $^{40}K$ - Q.4 (c) (iii) - a concept originally introduced in CH1 - especially since 1 mark equates to 2% of the total available.

'Roedd sawl papur yn dangos marciau uchel a dim ond nifer bach yn cael marciau isel iawn, yn dangos bod mwafrif o'r ymgeiswyr wedi ynateb yn dda. Y manylion 'roedd yn sefyll allan sydd yn angen sylw 'roedd yr atebion gwael i C.2 (f) - defnyddio gwybodaeth am electronegatifedd a grymoedd rhyngfoleciwlaidd. Nid yw'r cysyniad wedi ei ddeall yn dda. Hefyd cysyniad NMR. 'Roedd nifer mawr wedi cael ateb anghywir i gwestiwn 4(c)(iii) - rhowch rif mas a symbol yr isotop sy'n cael ei ffurfio trwy allyriad un gronyn β o un atom or isotop $^{40}K$ - cysuniad sydd wedi ei gyflwyno yn CH1 - yn enwedig am fod 1 mark yn werth 2% o'r cyfanswm.

**CHEMISTRY**

**General Certificate of Education 2009**

**Advanced Subsidiary**

*Chief Examiner:* Dr Peter Blake

**Unit Statistics**

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

| Unit | Entry | Max Mark | Mean Mark |
|---|---|---|---|
| CH6c | 1462 | 103 | 85.5 |

**Grade Ranges**

| | |
|---|---|
| A | 89 |
| B | 82 |
| C | 75 |
| D | 68 |
| E | 61 |

*N.B. The marks given above are raw marks and not uniform marks.*

## CH6c

### General Comments

This year has seen the last running of the module that has operated fairly successfully for some eight years. However the replacement module, CH6A, although different in structure, is based on the actual practical work of eight of the more popular experiments in the current scheme, namely I1, I2, I3 and I5 of the inorganic experiments and O1, O2, O3 and O5 of the organic experiments. Consequently this report may be of use.

Since the A2 work is intrinsically synoptic there will not be synoptic questions as such but the Regulator's requirement that there is some AO1 and AO2 assessment (knowledge and understanding of how science works and application of these) means that 10% of the total mark will be allocated to questions on each of these modules.

### General Points

The 2009 run of the modules appears to have gone smoothly with some very good work from many candidates. The work was well-presented and teacher result sheets were generally unambiguous.

Combinations of I1 and I3 with O1 and O3 were the most popular. Where I3 or O3 are used with their six unknowns it is important that all the candidates do not have the same combination in order to avoid the diffusion of information. The use of a few different combinations should deal with this.

Marks are still being shed through not writing data from weighings, burette readings and calculations to their full precision, such as 15.0, or even 0 for an initial burette reading and truncating a concentration of 0.0194 to 0.02 mol $dm^{-3}$.

### Individual Experiments

I1 This is a good test for candidates, who normally acquit themselves well. The note above concerning reporting results to three significant figures applies here. Vague answers to Q's 1, 2 and 4 sometimes caused mark loss and questions 7 and 8 dealing with overshoot and 10 comparing practical methods were, not surprisingly, found to be difficult.

I2 This was not very popular but worked well. It is critical that the teacher and candidates deal with the identical solution so that possible problems of supersaturation and temperature differences are avoided. If the anhydrous salt is used it should, to be fair to the candidates, be stated that x could be zero. Common ion and solubility effects in Qs 1 and 9 were not always clearly understood.

I3 Usually done well in the sense that unknowns were correctly identified, but plans were sometimes unconvincing. Clear statements of the number and colour of precipitates expected, comparison with the observations and reasoning are all needed. Marks were sometimes lost through not giving balanced equations or by giving equations that do not take place, such as magnesium nitrate with zinc sulfate.

I4 Done successfully by a few centres but not included in the new specification.

I5 No major problems here but it is worth repeating last year's comments that titration A must be held at around $70^{o}$, that an overshoot can lead to a large error in B through the 5:1 stoichiometry and that KI should be added to each solution **immediately** before it is titrated to minimize Mn(II) – catalysed air oxidation. Also the initial product may be recrystallised from water to improved purity.

I6 was not used and is not retained in the new specification.

O1 Was a popular choice, mostly but not exclusively O1A. Yields can still be poor, usually through errors in recrystallising, such as using excess solvent. Still a few errors in representing oxidation states, such as 3+, rather than +3 or III 3 is acceptable with no sign being taken as a positive) and problems in equation balancing, Q1b and 3b. The question on Test 4 was not very relevant and has been omitted from the new specification, that also now comprises only the A preparation.

O2 This has worked well and is retained in the new specification. It is noted that working at one-third of the scale stated in the procedure has been successful.

O3 Continues to be popular gives good results and is retained in the new specification. It should give a positive feedback into the candidate's understanding of organic chemistry. As in I3, the plan must be a real one and not a mini textbook downloaded from the internet. Marks are awarded not only for correct identification of the unknowns but for reporting all observations and inferences and giving appropriate equations. As previously stated, physical properties can provide secondary confirmation of inferences obtained from chemical tests. Also distinguishing between ester, amide and nitrile emerges as the trickiest part of the experiment.

O4, O6 & O7 These were hardly used and have not been retained in the new specification.

O5 Has generally worked well, is retained and includes a room-temperature alternative preparation that may be attractive where there are problems of the amount of Quickfit available.

**Conclusion**

Generally a very good performance by the A2 candidates this year, which, since the essentials of the experiments are retained in the new specification, should continue in 2010.

The skill and imagination with which the late Dr Keith Warren constructed this A2 coursework unit has been of lasting benefit which will hopefully continue into the future.

GCE Chemistry (Legacy) Examiners Report (Summer 2009)/WP Section/ALM
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