WJEC
CBAC

# GCE EXAMINERS' REPORTS

## CHEMISTRY (New)
## AS/Advanced

## SUMMER 2009

**Introduction**

Summer 2009 is the first award of the new AS. For all specifications there have been changes to the content of the units, and in many new marking criteria have been introduced and unit weightings altered. Also in some subjects there has been the withdrawal of internal assessment. However, the biggest change in most subjects has been the reduction from a three to a two unit assessment.

In moving to the new specification awarding bodies have sought to maintain the overall United Kingdom standard for AS, as measured by the proportion of candidates achieving grade A and by the proportion achieving a pass grade in each subject. Comparability between 'old' and 'new' specifications is measured in terms of the overall subject outcome and not in terms of unit outcomes. Many of the units in the new specifications will bear little relation to those in the old specifications. Even where they are very similar, it is quite likely that outcomes will be different. The expectation is that the number of grade As at unit level will decrease in a specification where the number of units is reduced, whilst the number of passes will increase. The overall cash-in outcome, however, will be maintained. These same principles will apply to the new A level where a six unit assessment is reduced to a four unit assessment.

**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.


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**CHEMISTRY**

**General Certificate of Education 2009**

**Advanced Subsidiary/Advanced**

*Principal Examiner:* Elfed Charles

**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 | 1963 | 80 | 40.6 |

**Grade Ranges**

| | |
|---|---|
| A | 54 |
| B | 48 |
| C | 42 |
| D | 36 |
| E | 30 |

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

## CH1

### General Comments

It was felt that the paper, although challenging, gave an opportunity for weaker candidates to show positive achievement. There were many excellent scripts which showed the value of sound revision and many more candidates gained 80% or more than scored 20% or less. There was some evidence that the paper was too long for a minority, and as always, a small number of candidates had been ill-advised to take the paper.

The highest mark was 80 and the lowest 1. As expected, Section A was answered well. In Section B the most successfully answered question as a whole was Q.8 with Q.9 being the least successfully answered. The easiest parts on the entire paper proved to be Q.8 (a) (i), Q.9 (b) and Q.5 (a) (i), while the hardest parts were Q.5 (a) (iii), Q.9 (a) and Q.7 (a) (iii) in that order.

It was pleasing to note that a significant number of candidates performed well in many of the calculation questions but while most managed to balance a chemical equation Q.8 (b) (i), forming an equation Q.6 (b) (i) still proved too much for the majority. It was also good to see that almost all were very knowledgeable in 'green chemistry'.

As in previous examinations the examiners noted that many candidates did not read the questions carefully enough and did not give specific answers to the actual question. Once again for many candidates, answers that required detailed responses often lacked depth of content and were sometimes contradictory. This was particularly true in Q.5 (a) ionisation energies, Q.6 (a) equilibrium and Q.7 (a) emission spectroscopy.

### Atebion Cyfrwng Cymraeg

Dim ond tua 7% o'r ymgeiswyr a safodd y papur trwy gyfrwng y Gymraeg. Ar y cyfan roedd safon yr atebion yn wanach na'r rhai drwy gyfrwng y Saesneg ond roedd safon y Gymraeg yn uchel iawn gyda defnydd cywir o'r termau cemegol. Yr unig le na welwyd hyn oedd yng nghwestiwn 6(a)(ii) – roedd y mwyafrif methu cofio'r term 'heterogenaidd'. Yn gyffredinol nid oedd iaith y cwestiynau wedi achosi unrhyw anhawster i'r ymgeiswyr, er efallai yng nghwestiwn 7(a)(i) roedd 'pam nad yw hydrogen ond yn allyrru …' wedi taflu rhai ymgeiswyr. Er hynny diffyg gwybodaeth a dealltwriaeth oedd yn debygol o fod y rheswm dros golli marciau ac nid yr iaith a ddefnyddiwyd ar y papurau.

### Section A

The candidates generally scored quite well in this section, with the average mark being just under 6 out of 10.

Q.1 The first question tested knowledge on basic ideas about atoms and all three parts were very well answered.

(a) (i) The main error was to define atomic number as 'the number of protons **and** electrons'.

(b) The main error was to put the outer electron in a 3d orbital.

Q.2 The first part was poorly answered; only about a third of candidates gave the correct answer. Most correctly stated that the reaction could be followed by measuring the volume of hydrogen produced but they failed to make any reference to time which is essential in measuring any reaction rate.

Both other parts were very well answered although in the second part some candidates lost the mark because the method to increase the reaction did not refer to cobalt.

Q.3 This simple mole calculation was quite well answered with around half giving the correct answer of 3 g.

Q.4 (a) This was disappointingly answered. Less than half gave the correct answer. As expected many drew a peak higher and to the left, but a significant number drew curves that substantially covered less area than the initial curve.

(b) A significant number gained both marks and the vast majority gained 1 mark for making one error. The main errors were to give the wrong sign or to leave out one of the bond energies (usually the C – C bond in the product) in the calculation.

**Section B**

Q.5 (a) (i) This was extremely well answered: over four fifths achieved the full 3 marks. Only careless plotting or not attempting the question lost any marks.

(ii) This was about ionisation energies and was poorly answered. Part I was easily the best answered and the vast majority obtained at least 1 mark. However many lost a mark through poor use of language e.g. ‘it has less shielding from the nucleus’ rather than ‘the (outer) electron is less shielded’.

In part II only about 1 in 3 candidates realised the significance of the increase in nuclear charge.

Part III proved to be the hardest part of the whole paper: less than a quarter of candidates managed to get 1 mark out of 2. Some managed to gain a mark for stating the electronic configurations of both nitrogen and oxygen, but not many were capable of explaining the idea of electron pair repulsion within the p-orbital of oxygen’s outer shell. Far too many explanations were given in terms of half full shell stability only.

(b) (i) This was an empirical formula calculation and 2 in 3 candidates obtained both marks. The most common error was to divide $A_r$ by mass giving the formula $Pb_3C_3O$ which obtained a mark due to consequential marking.

(ii) The first part was very well done, the most common error being doubling the molar mass of $Pb_3O_4$. The second part was a reacting masses calculation and while just under half the candidates achieved at least 2 out of 3 marks, an equal number failed to achieve any mark.

Q.6 (a) (i) The candidates had to explain how a catalyst speeds up a reaction. About four fifths of candidates managed to get 1 mark for 'lowers activation energy' but only about half of these were able to support this with a reference to 'an alternative route'. This was very disappointing since this answer has been in many previous mark schemes.

(ii) About three fifths correctly classified iron as a 'heterogeneous catalyst', although a wide variety of spellings was seen.

(iii) This part was about equilibrium and part I was poorly answered: only about a third of candidates gained at least 1 mark out of 2. Too many answers were not specific enough and vague answers such as 'increases reaction rate' (which was given in the stem of (a)(i)) gained no credit.

Part II was far better answered. Candidates clearly understood how the difference in the number of moles of gas between the reactants and products influences the equilibrium with an increase in pressure.

In part III most gained 1 mark out of 2. Candidates correctly stated that there was an increase in yield of ammonia, but far fewer could adequately explain why.

(iv) Although almost all candidates were able to suggest location advantages for the plant site, only just over a half could qualify these with an explanation as to why it would be an advantage. Unfortunately a significant minority incorrectly gave an advantage for being near the coast as 'easy to get rid of waste materials'.

(b) (i) Only about a third of candidates gave a correctly balanced equation. Many gave the wrong formula for ammonium sulphate even though it was given later on in the question.

(ii) The majority correctly explained why ammonia acts as a base in the reaction.

(iii) The percentage calculation was well attempted with most candidates achieving at least 1 mark out of 2. The most common errors were to use 14 instead of 28 for nitrogen in the calculation and incorrectly calculating the $M_r$ of ammonium sulphate.

Q.7 (a) This part was about the emission spectrum of hydrogen, a new topic in year 12 and it was poorly answered.

(i) Many candidates referred to energy being gained instead of emitted and there were many vague answers which gained no credit. However about a third gained a mark for using the term 'quantised energy levels' but only about a fifth could explain that visible light is emitted when an electron falls from a higher energy levels to the n = 2 level.

(ii) Candidates had to relate the visible spectrum to energy levels in a hydrogen atom and about half failed to score any mark out of a possible 3.

(iii) Only about a quarter drew the correct line that corresponded to the ionisation of the atom.

(b) (i) Fairly well answered with the majority correctly calculating the relative atomic mass of hydrogen, although some lost a mark for giving an incorrect number of significant figures.

(ii) Again only about a quarter of candidates realised that hydrogen molecules split to form atoms.

(c) (i) Many descriptions of a source of electrons were given and most obtained a mark.

(ii) Few candidates mentioned electric field but many got a mark for references to 'negative plates' or 'accelerators'.

(iii) Most got the mark for correct references to the creation of a vacuum in the mass spectrometer.

(d) Very well answered with about a third scoring all 4 marks. The main errors were stating 'helium atoms' instead of 'helium nucleus' and incorrectly describing the nature of a β particle.

Q.8 This was a question about sustainable energy and was the most successfully answered question in this section.

(a) (i) Almost all candidates got 1 mark (and the additional mark for QWC), but quite a few either neglected to offer a second reason or wrote about ozone depletion.

(ii) Again nearly everyone gained the first mark but only about a half either gave an appropriate description of how the process worked or correctly described the actual energy changes that took place during the process.

(b) (i) Generally well done with about two thirds correctly balancing the equation.

(ii) More than half the candidates achieved both marks in this enthalpy calculation and a significant number received 1 mark for making one error.

(iii) A difficult concept for the candidates only about a quarter managed to calculate the energy per gram of both fuels. Most simply compared the energy values in terms of kJ $mol^{-1}$ without any use of $M_r$.

(iv) Generally the answers were too vague with 'petrol is worse for the environment' being a common answer.

Q.9 This was the least successfully answered question in this section.

(a) Very poorly answered, only about a quarter remembered the term 'volumetric flask'. The most common answer being 'conical flask'.

(b) Almost all obtained this easy mark, only carelessness cost the mark.

(c) Most candidates correctly identified the anomalous result but many included it in the calculation of the mean titre and so lost the mark.

(d) This part involved the calculation of the percentage of sodium carbonate in a mixture and while many candidates scored at least 3 out of 5 (due to consequential marking) a significant number failed to score any marks.

(i) The most common error was not converting $cm^3$ into $dm^3$.

(ii) Many failed to divide by 2.

(iii) This was the best answered with many candidates gaining a mark consequentially by multiplying their answer to (ii) by 10.

(iv) Far too many failed to calculate sodium carbonate's $M_r$ correctly. Due to these errors it was not uncommon to see sodium carbonate's mass given as over 1000 g, despite the mass of the mixture only being 2.05 g!

(e) Reasonably well answered as a whole. Over half scored at least 3 marks out of 6, mainly due to correctly identifying a common error in titration or gaining the QWC marks. However vague answers such as 'human error' or 'not measuring properly' did not gain any credit. Some candidates realised that the percentage error should actually be higher if the end-point was overshot but most could not clearly explain why.

**CHEMISTRY**

**General Certificate of Education 2009**

**Advanced Subsidiary/Advanced**

*Principal Examiner:* D.H.Ballard, B.Sc., Ph.D., C.Chem. F.R.S.C.
Formerly 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 | 2533 | 80 | 35.7 |

**Grade Ranges**

| | |
|---|---|
| A | 52 |
| B | 45 |
| C | 38 |
| D | 32 |
| E | 26 |

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

## CH2

### General Comments

This was the first examination in this unit for the new GCE specification, and the examiners had tried to design the paper to give a new ‘flavour’ to reflect the current changes in GCSE Sciences.

The range of marks obtained by candidates taking this unit was very wide, when compared to AS papers in the legacy specification. The paper total has increased to 80 but even so there were over three hundred candidates who failed to gain fifteen marks. Conversely some excellent scripts were also seen, with over fifty candidates who gained a very creditable 70, or more, marks.

At the last INSET meetings with teachers, some colleagues had expressed a little concern about the more open-ended approach to some questions. However, as in the January CH1 paper, the examiners noticed that candidates coped well with this question style, except for the last question. This examination contains less mathematical material and more ‘clear learning’. It is apparent from looking at the papers that some candidates are not learning the material adequately and consequently, the responses seen were often poorly expressed and lacking in detail.

Some questions required the use of formulae and equations. It was disappointing to see that a number of candidates lack the knowledge of the basic formula of compounds such as calcium hydroxide, and even the symbol for fluorine, although this was given on the data sheet.

In conclusion, the examiners feel that to gain creditable marks in this unit, thorough learning of the material is essential, particularly in the organic chemistry section. It is simply not possible in this paper, to gain a measure of marks by mainly relying on basic mole calculations.

### Section A

Q.1 Most candidates gained this first mark, correctly describing some physical properties of graphite.

Q.2 (i) It was disappointing to see that many candidates did not know that hydrogen was a product of the reaction of barium metal with water. Many could not give the formula of barium hydroxide and some thought that barium oxide was a product. One candidate wrote:

$$2\ Be + 2\ H_2O \rightarrow 2\ H_2Ba + O_2$$

This nearly balances, except beryllium is used! Half marks cannot be used in this new specification and therefore the equation needs to be completely correct to gain any credit. It was disappointing to see symbols being used with the incorrect use of upper and lower case letters. This problem seemed to occur in a number of questions.

(ii) The test for aqueous barium ions was generally well done although the second mark was dependent on the reagent being correct.

Q.3 (i) A clear description of why E-Z (trans-cis) isomerism occurs is not always easy to express clearly and this was seen in some of the answers received.

(ii) The reagent for the oxidation of a primary alcohol was usually correct, may still cannot spell ‘potassium’.

(iii) Many candidates gained credit for ‘oxidation’ or ‘redox’.

Q.4 (i) This question asked candidates to give an ionic half equation for the formation of fluoride ions from fluorine gas. This proved to be difficult for many candidates. Some used the wrong symbol Fl, others believed that fluorine was monatomic and a number gave the products as $F^+$ and $F^{--}$.

(ii) Most answers stated that fluorine was highly electronegative, and this was acceptable. Some candidates wrote equations that did not show electrons.

**Section B**

Q.5 (a) (i) The atom economy for the reaction was 18.8% and many candidates gained both marks.

(ii) The number of moles of calcium chloride in 100 $cm^3$ of the solution was 0.405. A number of candidates could not then convert it to a concentration in mol $dm^{-3}$. Some, sadly, used the relative molecular mass of other compounds given in the equation.

(iii) The equation for the reaction of calcium with hydrochloric acid was generally correct.

(iv) Many candidates gave, correctly, brick red. Crimson and red were also seen and gained no credit.

(v) The test for aqueous chloride ions was usually correct but some used sodium hydroxide, as if they were hydrolysing a halogenoalkane.

(vi) Many excellent answers were seen for this dot and cross diagram. The question stated that calcium chloride was an ionic compound but a number of candidates then drew it as covalently bonded, sometimes with charges. Some candidates gave the charge of the calcium ion as +2 instead of 2+, this was penalised.

(vii) This was an easy mole calculation and many candidates gained both marks.

(viii) The examiners expected candidates to state (or imply) in their answer that a co-ordinate bond was a form of covalent bond but this was not always given. What was written sometimes lacked clarity.

Q.6 (a) (i) The question asked for the formulae of the species in a sodium chloride structure. A common error was to give Na and Cl, without any indication that they were ions. Others simply wrote the words sodium and chlorine.

(ii) Both co-ordination numbers were requested. A few candidates merely wrote 6.

(iii) The examiners were looking for a comparative answer. Responses stating that the caesium ion was a large ion gained no credit. There were a number of references to caesium atoms, which were also unacceptable. A few candidates wrote that a caesium molecule is bigger than a sodium molecule.

(b) (i) This was a more challenging question and it was unusual to award both marks for an explanation of the reasons why sodium chloride is soluble in water.

(ii) Nearly all candidates completed the table of ‘weighings’ correctly. Most then went on to provide a correct answer for the solubility of sodium chloride in water.

(c) Many candidates merely reworded the question by writing ‘the outer electron of a sodium atom was found in the s block’, rather than ‘its outer electron was found in an sorbital’.

(d) The examiners were disappointed that so many candidates were unable to assign oxidation numbers (states) to the reactants and products. The question also asked candidates to explain which species was being oxidised in terms of the oxidation number change. The response was not always done in this way and some wrote about a loss of electrons, which was not required.

Q.7 (a) (i) Fractional distillation can occur because of differences in boiling temperature – this key feature was omitted by many candidates.

(ii) The required molecular formula was usually correct but some gave the name. A few candidates provided a formula showing an odd number of hydrogen atoms. All hydrocarbons have an even number of hydrogen atoms per molecule.

(iii) The description of cracking was generally correct and was an easy two marks for many candidates.

(iv) A large number of candidates did not read the question correctly and gave an isomer of 2, 2, 4-trimethylpentane, which was not a straight chain isomer. Attention needs to be given to the terms ‘straight chain’ and ‘branched chain’.

(b) (i) This question was about dichloromethane. Some candidates lost marks by discussing the formation of chloromethane. Generally, however, many candidates gained a number of marks in this section.

(ii) This was a natural extension of (i), exploring other possible radical reactions. Some decided that the compound with a molecular ion peak at m/e 98 must be 1, 1- dichloroethane, rather than its 1,2- isomer. The former would be difficult to make by a common radical process from $\bullet CH_2Cl$ and lost the candidate a mark.

Q.8 (a) (i) The mistakes in the colour changes for bromine and the incorrect naming of the bromo-compound were generally recognised by most candidates.

(ii) The need to use sodium hydroxide before testing for a chloride was well understood. Many candidates then showed a lack of understanding of the hydrolysis process and the subsequent identification of the bromide ion. If hydrochloric acid were to be used in place of nitric acid, interference would occur with the identification of the bromide, but few could gain this mark. However, nearly all candidates knew that silver bromide is not completely soluble in dilute aqueous ammonia but will dissolve in concentrated aqueous ammonia.

(b) (i) Nearly all candidates correctly stated how infrared spectroscopy could be used to identify any unreacted but-2-en-1-ol in 1-bromobut-2-ene.

(ii) Many candidates find questions about intermolecular bonding difficult to answer in an unambiguous way. There were six marks for this question but it was not common to see responses gaining more than four marks. In many cases marks were lost for not stating whether a type of bonding was present in one or both of the compounds. The examiners felt that nearly all candidates had some knowledge of this topic but many could not present their ideas in a clear and concise way.

Q.9 (a) (i) The examiners were looking for a response indicating that 'lone pair/bonding pair repulsion' is greater than 'bonding pair / bonding pair repulsion'. In many cases the examiners were not confident that candidates were trying to express this idea clearly. Statements such as 'the hydrogens are pushed closer together' were not seen as 'close enough' to gain a mark.

(ii) Most candidates recognised the electronegativity differences between nitrogen and hydrogen in ammonia but fewer candidates gained both the available marks.

(b) (i) An equation showing the hydrogenation of an alkene and the naming of the alkane produced were seen by the examiners as two easy marks. It was surprising how many candidates invented an organonickel compound as the product.

(ii) Most candidates gave a realistic answer for the use of a smart alloy.

(iii) The tetrahedral angle was well known.

(c) (i) The pressure used in this process was generally correct. It is easier to provide this response in atmospheres rather than the more correct kPa. At least one candidate gave an answer correctly in MPa.

(ii) The reverse process, elimination, was usually correct, as was a suitable catalyst for this, of which several were acceptable. The commonest catalysts mentioned were aluminium oxide and concentrated sulphuric acid.

(d) (i) Most candidates provided a correct formula for 'halothane' but a few candidates used the wrong symbol, Fl, for fluorine.

(ii) There were a number of acceptable uses for a halogenoalkane and it was unusual to not award this mark.

(e) This question provided quantitative data about the effect of CFCs on the ozone layer. Many candidates found this question challenging and it was uncommon to see an answer that merited both marks. There were a number of acceptable answers but only a few candidates really got to grips with the information provided.

Dr Rhodri Thomas has provided this information about those candidates taking the examination through the medium of Welsh.

**CYMRAEG**

Gwelwyd safon iaith da iawn yn y papurau cyfrwng Cymraeg eleni, gyda'r mwyafrif yn ennill nifer o'r marciau am ansawdd eu cyfathrebu ysgrifenedig. Roedd iaith rhai ymgeiswyr yn rhy amhendant, ond roedd cynifer o ymgeiswyr cyfrwng Cymraeg a chyfrwng Saesneg yn dangos y broblem hon. Rhaid sicrhau fod atebion yn hollol sbesiffig ac yn osgoi'r defnydd o 'e' a 'hi' lle nad yw'n glir beth y maent yn eu cyfeirio ato.

Defnyddiwyd yr enwau cemegol cywir am y cyfansoddion a'r adweithiau trafodwyd gan y mwyafrif. Gwelwyd rhai problemau yn y defnydd o dermeg, ac roedd yr un cymysgwch o dermau 'atom', 'moleciwl', 'grŵp' ac 'ïon' yn cael eu defnyddio gan rhai ymgeiswyr heb ystyried beth yw'r un sydd ei hangen yn y cwestiwn. Roedd hwn yn broblem yn enwedig yn y cwestiynau canlynol:

Q.3 (i) Roedd nifer yn trafod dau moleciwl gwahanol wedi bondio i'r un atom carbon yn hytrach na grwpiau.

Q.6 (a) (iii) Roedd nifer yn trafod yr atomau cesiwm a sodiwm a'u radiysau atomig yn hytrach na'r ionau hyn a'u radiysau ïonig.

Q.7 (b) (i) Roedd y term ymholltiad homolytig yn cael ei ddisgrifio'n ymholltiad homogenaidd.

Q.8 (b) (ii) Trwy gamddefnyddio'r termau 'atom' a 'moleciwl' newidiwyd ystyr atebion rhai ymgeiswyr o fod yn gywir i fod yn anghywir.

**ENGLISH**

A good standard of language use was seen in the Welsh medium papers this year, with the majority earning many of the marks for the quality of written communication. The language of some candidates was too imprecise, but this problem was common to both Welsh and English medium scripts. It is crucial that the answers given are very specific and avoid the use of 'it' when it is unclear what 'it' refers to.

The majority could use correct chemical terminology for compounds and reactions. There were some problems apparent in the use of certain terms, particularly the confusion of the terms 'atom', 'molecule', 'group' and 'ion' where candidates use them without though as to the correct one for each context. This was a particular problem in the following questions:

Q.3 (i) Many discussed the two molecules joined to each carbon atom rather than the groups attached to each carbon atom.

Q.6 (a) (iii) Many discussed the caesium and sodium atoms and their atomic radii, rather than the caesium and sodium ions and their ionic radii.

Q.7 (b) (i) The term homolytic fission was frequently described as homogeneous fission.

Q.8 (b) (ii) By misusing the terms 'atom' and 'molecule' in this question, the meaning was changed totally from a substantially correct answer to one that was incorrect.

## CHEMISTRY

## General Certificate of Education 2009

## Advanced Subsidiary/Advanced

*Principal Examiner:* Dr Peter Blake

**Unit Statistics**

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| CH3 | 2541 | 60 | 47.6 |

**Grade Ranges**

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|---|---|
| A | 52 |
| B | 47 |
| C | 42 |
| D | 37 |
| E | 33 |

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## CH3

### General Comments

The first run of the new specification for this module appears to have proceeded fairly smoothly without any major hitches, aided by the fact that the core Implementation sections of the nine experiments are essentially unchanged. One or two minor errors and inconsistencies have emerged and these will be corrected online.

### General and Presentation

Presentation was generally excellent with only a few minor problems. Paper clips are still sometimes used and usually become detached in the sacks. The two experiments must always be fastened together and fronted by the cover sheet. The candidates must only return the pro forma along with any associated graphs and additional sheets firmly attached and should not include the instruction sheets or any rough work that only interfere with smooth marking. It is important that candidates do not see the detailed mark schemes, especially since these contain model answers to the AO1 and AO2 questions.

### Shared results

It is regrettable that a few candidates have by copied or shared results despite having signed and affirmed on the cover sheet that the work is entirely their own. Mark teams are vigilant in looking for suspect results and when two candidates have identical numbers for all their titrations and masses or five identical times of four figures each in kinetics it is obvious that the odds against this occurring by chance run into millions to one. WJEC investigates all suspect cases brought to their notice by markers.

Teachers can help to prevent this by stressing the importance and meaning of the statements on the front cover and pointing out that any such occurrence can lead to penalties including disqualification from at least the unit.

The essence of the integrity of the coursework and fairness to all candidates lies in that the work is the candidate’s own **under all circumstances**. The only exception is in the kinetics experiments where there is the possibility of candidates combining their own results to give an extended group analysis of the data: this however must be arranged in advance between the centre and WJEC, with the mark scheme being modified accordingly. To date, this option has not been taken up.

### General aspects of the experiments

### Planning

In the new structure the planning section is usually allocated five marks, three of which are for AO1 questions (see later). This reflects the realism that the opportunity for planning is limited at AS. Also a mark is no longer allocated to stating the aim of the experiment. What is required is a concise statement of what is to be done that could be followed and repeated by a chemist. There is no need to explain standard procedures or apparatus. It might be better to provide a few more lines on the pro forma to suit most candidates but extended accounts are not needed. However the bold but naughty plan given by a few candidates, namely “ I followed the instructions given” did not attract any marks.

**Implementation**

This normally comprises 50% of the marks and will be considered individually.

**Analysis**

Again considered individually.

**Evaluation**

Three of the five marks are taken up by AO2 questions. The remainder is associated with considering errors, estimating the precision of the results and, on the basis of this, stating or restating the results to a sensible number of significant figures, which will usually be three, plus or minus one. Matters are improving here with simple estimates of precision being made and significant figures, rather than the misleading decimal points, being used.

**The Questions**

The Regulators have required that AO1, knowledge and understanding of How Science Works, and AO2 application of these, are also assessed and each now make up 10% of the total mark.

It is stressed again, especially for teachers new to the coursework that these questions are open book with all notes, textbooks and resources normally available in the laboratory able to be consulted. The questions may or may not relate to the theory specification.

**Individual experiments**

**3.1A-D Thermochemistry**

Since many of the points apply to all of these they are taken together.

Q.1 Choice of experiment

Amazingly, despite the statement in **BLOCK CAPITALS** at the top of the Candidate Instruction Sheet and on the Advice notes that three-place balances are essential for 3.1B and 3.1C, two centres having only two-place balances have done these. It is worth pointing out where the problem lies by taking an extreme but nonetheless possible case.

The teacher weighs 0.10g of Mg to two places but the true mass is 0.0951g. The candidate's 0.1g is in fact 0.1044g. The difference in masses are thus 9.5% giving a $\Delta T$ difference of 9.5% or 0.95 degrees on a10 degree rise. If the candidate has a true error of 0.3 degrees he or she would be awarded 5 marks. However the apparent error is now 0.3 + 0.95 = 1.25 degrees resulting in zero and a loss of 5 marks, over 16% of the total, **through no fault of the candidate.** Extreme but possible, so this is why Mg experiments should not be used with two-place balances.

Q.2 Quality of materials

Again a matter of crucial importance for the fair assessment of candidates. Listing again typical values for good quality and dry materials (and correcting two errors in the guidance notes) we have $\Delta T/g$ as follows;

Mg 95, MgO 15, $MgCO_3$ 2.7, $NaHCO_3$ -1.4 and $Na_2CO_3$ 1.6.

Obviously some variation is to be expected but the values reported on the Teacher Results Sheet include Mg 247! and 50, MgO 2.8 and 4.7, $MgCO_3$ 8 and $Na_2CO_3$ 1.0.

These materials are not what they purport to be, they may be damp, oxidized, contaminated and, worst of all, heterogeneous. It is no exaggeration to say that candidates' grades may well be affected by being given suspect materials. None of these solids is expensive and surely the only safe practice is to open new bottles every year and check their quality in advance, since problems have arisen even with fresh materials.

Q.3 Good Practice

There are some common reasons why candidates fail to get the best out of their work and these often show up on their graphs.

(a) Scale too small; why start from T = 0 and have a $\Delta T$ of about 2cm?

(b) Inefficient mixing; the plot meanders up to a maximum at some time making $\Delta T$ difficult to estimate.

(c) Poor insulation; temperature falls rapidly from maximum making extrapolation difficult.

(d) Extrapolation to time zero not the point of addition.

(e) Misreading the graph for $\Delta T$; often caused by bizarre choice of scale. Markers correct this where possible but it remains the responsibility of the candidate.

Q.4 Electronic data capture

The use of this is welcomed when possible but two points need to be made. In some cases the plots drawn automatically are of poor quality and inadequate for a precise measurement of $\Delta T$ so a manual plot is needed. Also a table is needed in the mark scheme; automatic printing of this is acceptable but otherwise must be done manually.

Q.5 Analysis and Evaluation

There are a few points to note. The sign of $\Delta T$ still causes problems. If T rises $\Delta T$ = T(final) –T(initial) is positive and vice versa. Associated with this are frequent errors in relating the signs of temperature changes and enthalpy changes. All that is needed is to say that if $\Delta T$ is + then $\Delta H$ is – and vice versa. Use of the words exothermic and endothermic only confuses matters. The problem arises because what is measured is the temperature and energy of the water surroundings which have, say, increased through receiving the energy lost from the reacting system, the enthalpy of which has decreased.

The calculations of $\Delta H$ values cause few problems; care needs to be taken with signs, not mixing joules and kilojoules, scaling up to molar amounts and the need in 3.1D for two moles of hydrogencarbonate.

**3.2A and B – Kinetics**

Few serious problems have been noted with these experiments which usually work well and give good results.  The following can lead to loss of marks;

(a) Lack of precision.

(i) The volumes used in the tables must reflect the precision of the burette, e.g., 10.0 and not 10 $cm^3$.

(ii) 1/time values. A time of 26s has been written as 0.03 instead of 0.038 giving an error of 26% and a useless plot.

NB it is quite acceptable to write down the exact time shown by the electronic timer, such as 25.72s even if the precision is much less.  It is sound practice to record the primary data from any output as it appears and not attempt to make any adjustment while the experiment is in progress.

(b) Insufficiently wide range of reactant concentrations.  This should be at least threefold.

(c) Sensible reaction times.  Ideally these should be between 20 and180s. Shorter times will have mixing time errors and endpoints are difficult to determine in long times.

(d) Graphical plots

The usual factors contribute to the final mark, namely title, correct labelling of axes, correct allocation of x and y axes (1/time on y axis), full use of graph paper to accommodate results (no need to start at zero on 1/time axis) and correct plotting of data.

Also all points must be plotted including the trial run and, in particular in 3.2B, each graph must have four points since one result is common to both.

Estimation of precision of result.  We need to be liberal at this level and semi-quantitative estimates based the scatter of points, temperature fluctuations, volume errors and time reading errors are all acceptable.

(e) Dependence of rate on concentration(s)

This forms a question in either the Analysis or Evaluation sections and requires a fairly precise answer such as “the rate is directly proportional to the concentration”.

Vague answers such as “the rate increases with concentration” or ‘rate increases with volume” are unsatisfactory. Answers such as “1/time is directly proportional to the volume of peroxide” are strictly correct but do not address the specific question which says “rate” and" concentration”.

**3.3A-C - Titrations**

These were usually done well. The main factor is the accuracy of titration and this discriminates between the majority who titrate well, some who perform titrations of very high quality and a few who have little idea of how to titrate. Aside from this there are some points where marks are unnecessarily wasted. These are:

(a) Not preparing a proper table having rows for final volume, initial volume and difference.

(b) Not recording **all** burette volumes to 0.05 $cm^3$, especially writing 0 instead of 0.00 if this is the start reading.

(c) Not ensuring that chosen readings differ by not more than 0.25$cm^3$.

(d) Not indicating which readings are being averaged and averaging incorrectly or not to four significant figures.

Similarly in 3.3C not recording the KHP mass to the number of significant figures appropriate to the balance used.

Analysis of the results causes few problems with occasional inversions of titration volumes. The check is to realize that if more of solution A is needed than B then A has the lower concentration.

**Destruction of information and significant figures**

(see also Circular 67)

This casual loss of hard-won experimental information can be seen in all the coursework experiments. In thermochemistry a measured $\Delta T$ of 8.3$^o$can be recorded as 8$^o$, in kinetics a 1/time value of 0.034 $s^{-1}$ may appear as 0.03$s^{-1}$ and in titrations a concentration result of 0.0943 mol $dm^{-3}$ may be recorded as 0.09 or perhaps even 0.1mol $dm^{-3}$.

The opposite, less serious, offence to truncation is to record the full output of the calculator as the final result. It is acceptable to use this through the calculation but the final result should have some physical meaning. Since the estimates of precision carried out will result in the region of 1% errors, then reporting the result to three +/- one significant figures would be realistic. Thus 0.1234567 mol $dm^{-3}$ becomes 0.123 mol $dm^{-3}$.

**Conclusion**

It is hoped that this rather long report will be of help to teachers in seeing where their students can improve their performance in coursework.

It should not however obscure the fact the both candidates and teachers have adapted very satisfactorily to the new specification without any major problems arising.

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