



ASSESSMENT and  
QUALIFICATIONS  
ALLIANCE

General Certificate of Education

**Chemistry 5421/6421**

**Report on the Examination**

*2006 examination - June series*

- 5421      Advanced Subsidiary
- 6421      Advanced

Further copies of this Report on the Examination are available to download from the AQA Website:  
[www.aqa.org.uk](http://www.aqa.org.uk)

Copyright © 2006 AQA and its licensors. All rights reserved.

#### COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX.  
*Dr Michael Cresswell Director General.*

# Contents

## AS Units

CHM1	Atomic Structure, Bonding and periodicity.....	4
CHM2	Foundation Physical and Inorganic Chemistry.....	7
CHM3/W	Introduction to Inorganic Chemistry.....	9
CHM3/P	Practical Examination.....	11
CHM3/C	Centre-Assessed Coursework.....	13

## A2 Units

CHM4	Further Physical and Inorganic Chemistry.....	17
CHM5	Thermodynamics and Further Inorganic Chemistry.....	20
CHM6/W	Synoptic Assessment.....	23
CHM6/P	Practical Examination.....	24
CHM6/C	Centre-Assessed Coursework.....	26

Mark Ranges and Award of Grades.....	30
--------------------------------------	----

## CHM1

### General Comments

Overall performance on this paper was very similar to that in the June 2005 paper, with similar strengths and weaknesses being identified. As in the previous Summer examination, the quality of work varied widely. Many excellent attempts were seen and high marks were scored, a fitting reward for those candidates who had prepared themselves conscientiously for the examination. However, it was again clear that a worryingly high proportion of the candidature had made little preparation for the examination. Low scores were very common, with many candidates lacking much of the basic knowledge required at this level. Many candidates were unable to quote standard definitions or to give convincing explanations for basic trends. By failing to learn such material, candidates surrendered some relatively easy marks; marks which they could ill afford to lose. As in previous years, terms such as *atom*, *molecule*, *ion*, *macromolecule* and *intermolecular* were used incorrectly and out of context. Similarly, arguments based on the presence of *van der Waals' forces* in solid silicon and *hydrogen bonding* in the Group II elements confirmed that *bonding* is an area of the specification poorly understood by many candidates.

In question 2, many candidates made no attempt to complete the diagrams in part (a). This question is very clearly labelled as part (a) on the question paper and 2 marks are equally clearly assigned to it; it most unfortunate if some candidates missed out this question by accident. Centres are encouraged to ensure that their candidates examine each question carefully before attempting to answer it, so that each part requiring an answer is identified.

The majority of candidates attempted all of the questions, although a few made no attempt at some parts of the paper. As in previous years, this is not felt to be due to lack of time but rather due to lack of adequate preparation, and/or time being wasted producing unnecessarily long answers to some questions.

### Question 1

The meaning of the term *isotopes* was generally well understood but some candidates answered in terms of  $A_r$  and mass number, rather than in terms fundamental particles as required by the question. Some answers compared the numbers of protons and neutrons present but made no mention of the species in which these particles were present. Part (b) was often correctly answered but errors in the mass number, and more particularly in the identity of the element, were quite common. A few candidates lost credit by quoting the mass number as 37.0 or by writing their correct deductions separately, rather than as a complete symbol for the atom. Parts (c)(i) and (c)(ii) were, in general, well answered, although some errors in the electron arrangement were seen. Also, although most candidates were able to calculate the  $A_r$  value, some ignored the rubric of the question and failed to quote their answer to 1 decimal place. In part (c)(iii), most candidates made an appropriate suggestion as to what should be adjusted in the mass spectrometer but the majority of explanations were vague, incomplete and unconvincing. Frequently, candidates referred to the *size* of the ion rather than its *m/z ratio* and many failed to specify the direction of the proposed change of magnetic/electric field or to link it with the specific effect it would have on the trajectory of the ion. Similarly, explanations of the effect of a given field strength on ions of different *m/z* values lacked a specific link between *m/z* value and the degree of deflection experienced by the ion. Some explanations simply re-stated the question, while in others

*diffraction* and *reflection* were substituted for *deflection*. In part (c)(iv), the full symbol,  $^{72}\text{Ge}^{2+}$ , was rarely seen, although many candidates correctly deduced that the two ions must have the same  $m/z$  value. It was not uncommon, however, for candidates to suggest that the  $^{72}\text{Ge}$  ion must have split into two equal pieces, or that it was in fact an  $^{36}\text{S}_2^{2+}$  ion.

### Question 2

In a surprisingly large proportion of instances, the diagrams were either left blank or were incomplete. Of those candidates who did attempt part (a), most coped well but it was not unusual for the diagram of sodium metal to contain negative charges, or for the sodium chloride diagram to show the same change on adjacent ions. Many of the explanations in part (b) were poorly done. Frequently, the answers to parts (b)(i) and (b)(ii) lacked any reference to the attraction between the relevant species. The most common answer to part (b)(iii) was to state that *ionic bonding is stronger than metallic bonding*, as if this were a universal truth, rather than deducing that this comparison was true in this case. In part (c), candidates frequently referred to sodium being a better conductor than sodium chloride; although some did then go on to clarify matters by explaining that sodium chloride would only conduct when molten. It was very common to see references to *covalent bonds*, *van der Waals'*, *dipole-dipole* and *intermolecular forces* in this question. In part (c), some good explanations were seen but, all too often, they were vague and incomplete. Many candidates were aware of the importance of delocalised electrons to the conductivity of sodium; however, relatively few described them flowing through the metal. The lack of conductivity of sodium chloride was often ascribed to there being no *free electrons* in the salt. Also, a significant minority of candidates simply referred to the presence or absence of *charge carriers*, without identifying them. Very few candidates explained the lack of conductivity of solid sodium chloride in terms of its immobile ions. Parts (d) and (e) were comparatively well answered, although the malleability of sodium being was sometimes attributed to the presence of *weak intermolecular forces*. The empirical formula calculation was usually accurately calculated and the equation correctly balanced.

### Question 3

Part (a)(i) was often poorly answered. Answers in terms of  $M_r$  and mass were quite common, as were statements such as the *number of atoms/particles in 1g of substance*. Candidates, who correctly defined a mole in terms of the Avogadro constant, often spoiled their answer by misquoting its value or by referring to there being the Avogadro number of atoms, rather than molecules, in a mole of molecules. Some good answers linking the mole to the number of atoms of carbon in 12.00 g of  $^{12}\text{C}$ , were seen.

In part a(ii), the majority of candidates, when attempting to calculate the number of moles of oxygen formed in the reaction, divided the mass by 16 rather than by 32. Also, in part (a)(iii), a surprising number of candidates used 908, rather than 227, as the  $M_r$  for nitroglycerine. Similarly, there were many errors in determining the total number of moles of gas formed; the most common error being 28, rather than 29. As the remaining marks were awarded consequentially, many candidates still achieved a reasonable mark for this calculation. In part (b), the Gas law expression was well known and the question was well answered. However, a significant number of candidates, having correctly calculated the pressure and quoted its units as Pa., thereby earning all 4 marks, chose to convert their answer into larger pressure units. Errors in this conversion were quite common and so the final mark was lost.

#### Question 4

While many candidates completed the diagram in part (a) successfully, errors were very common. Silicon was frequently shown with a melting point below that of aluminium, chlorine with a melting point greater than that of sulphur and, in a few instances, argon with a melting point close to the top of the graph. Part (a)(ii) was quite well answered and most candidates offered an acceptable description of the structure of silicon. Many candidates correctly explained the high melting point of silicon in terms of the need to break strong covalent bonds, however, vague references to covalent bonds being *loosened* were quite common. A minority of candidates spoiled their answers completely by referring to the structure of silicon being ionic or possessing intermolecular forces. In part (a)(iii), while many correct answers were seen, a substantial number were either too vague to earn credit or stated that the difference in boiling point was the result of having to break more covalent bonds in sulphur than in phosphorus. Part (b) was surprisingly poorly done. A significant minority of candidates described an *increasing trend* in the boiling point from Ca to Ba. Others, who had correctly identified a decreasing trend, clearly failed to recognise that all of the elements involved were metals and referred to decreasing attractions between the nucleus and the *outer* electrons or the *bonding* electrons. Many of the weaker candidates sprinkled their answers with references to *intermolecular forces* or *molecules*.

#### Question 5

This question clearly differentiated between those candidates who had taken the time to revise thoroughly, and those who had not. In part (a) the trends in solubility were generally well known but occasionally reversed. It was quite common, however, for candidates to hedge their bets and to suggest the same trend for both the sulphates and the hydroxides. A minority of candidates described the trend in the solubility/reactivity of the metals, rather than of the specified metal compounds. The details of the sulphate ion test were not well known. Barium, barium sulphate,  $\text{Ba}^{2+}$  ions and even silver nitrate were suggested as being suitable reagents for the test. Some candidates confused Ba with Be and so earned little credit. Some candidates thought that the addition of the acid constituted the whole test, rather than being used to remove  $\text{CO}_3^{2-}$  ions and so eliminate the occurrence of false positive results. Some candidates, who had earned credit for a correct ionic equation for the reaction, then wrote an incorrect full chemical equation and so lost the mark. A number of candidates misinterpreted the question and offered a test to identify the nitrate ion. This test is not part of this module but correct answers earned full credit. A few candidates offered both tests, rather than simply reporting a negative outcome to the sulphate ion test when performed on sodium nitrate. Many of the diagrams in part (b)(i) were poorly drawn, and many instances of one or more lone pairs of electrons being shown on the B atom were seen. Those candidates who tried to indicate the three-dimensional nature of the structures using wedges and dotted lines, frequently used them incorrectly. While many candidates correctly named the shapes of the species, it was not unusual for the shape of the  $\text{BF}_4^-$  ion to be described as being *distorted tetrahedral*. In most instances, the correct bond angle was quoted for the  $\text{BF}_4^-$  ion, however, bond angles of  $107^\circ$  or even  $105^\circ$  were quite frequently seen. An explanation for the shape of this ion was rarely attempted and, when it was, it was often given in terms of repulsion between Fluorine atoms rather than of bonding electron pairs. *Equal* repulsion was rarely seen. Part (b)(ii) was quite well answered. Most candidates were able to show an understanding of dative covalent bonding, although a fair number of candidates predicted that there was a lone pair of electrons on boron which was donated to the fluoride ion when the bond was formed.

## CHM2

### *Question 1*

Part (a) was generally well done by most candidates. The most common error was not referring to standard states. The calculation in part (b) proved more demanding for students than some previous enthalpy calculations with many candidates giving the incorrect answer of  $-7\text{kJmol}^{-1}$ . A large number of candidates did not give the correct mass or correct temperature rise in part (c) and therefore only scored the mark for the  $Q = mc\Delta t$  equation. Many of the candidates who did calculate the heat evolved then failed to calculate molar quantities. The calculation in part (d) proved very difficult for candidates with very few scoring full marks. Common errors were incorrect mass, incorrect temperature rise and lack of conversion to molar quantities. Candidates should know that exothermic reactions are shown by a negative sign e.g.  $-53.3\text{kJmol}^{-1}$ . In part (e) many candidates failed to make the comparison regarding heat loss between the two experiments.

### *Question 2*

This question was not answered well. Only a few candidates scored high marks. The most common wrong answer in (a) (i) was Y. In part (a) (ii) many candidates did not mention collisions or the fact that during collision some particles gained energy whilst others lost energy and slowed down. Part (b) was the most well done section in this question with candidates being able to draw a Maxwell - Boltzmann distribution curve at a higher temperature. In part (c) (i) many candidates made no reference to few collisions having the necessary activation energy. Part(c) (ii) was not answered well by many candidates since they did not read the question and relate their answer to the proportion of successful collisions. Many candidates referred to increasing the concentration or pressure which would simply increase the number of successful collisions. Even those who gave the correct answer of catalyst did not fully explain how this increased the proportion of successful collisions.

### *Question 3*

There were a surprisingly large number of candidates who missed out the word rate in their answer to (a), simply stating that the forward reaction was equal to the backward reaction. Many candidates did not refer to constant concentrations of reactants and products. Parts (b) and (c) were generally well answered by most candidates. Part (d) was answered well apart from the weakest candidates. Errors included no reference to the exothermic reaction in part (d) (i) and failure to give a comparative answer in (d) (ii).

### *Question 4*

This question was relatively straightforward apart from part (a) which proved difficult for many candidates since many could not express themselves clearly. The equations in (b) and (c) were either well known or completely wrong. The answers to (d) and (e) although relatively straightforward, discriminated well.

***Question 5***

The answers to part (a) were good from all but a few candidates. The answers to part (b) varied considerably with good candidates scoring high marks and those who had not learnt halogen chemistry doing very poorly. The equation required in part (c) was known by many candidates although some gave the equation showing further decomposition to oxygen. Whilst those who gave the correct equation were generally able to explain, using oxidation states, that water was not oxidised, quite a lot of candidates lost marks by stating, incorrectly, that water was not oxidised - it was reduced.

## CHM3/W

### General Comments

The paper was very accessible. Lower achieving candidates could make progress on every question and higher achieving candidates had a challenge. All marks on the paper were scored and correct answers were seen for every part of every question, with occasional scripts at full marks. It remains a matter of concern to see scores below five marks as has occurred in June papers in the past, suggesting that some of the candidates were not ready to take this paper. The structure of the paper and the scheme of marking aimed to ensure that all candidates were able to show what they knew, understood and could do. Many candidates lost marks from incomplete names and structures or from incomplete information about a reagent or an observation. Even the weakest candidates could usually make some progress with mechanisms and these questions often yielded a high proportion of the overall mark for these students. Candidates should be encouraged to express their thoughts using sentences when defining a concept or explaining an idea. Care should be taken in the presentation of organic structures with clearly presented bonds, where appropriate. When drawing mechanisms, candidates should be encouraged to ensure that curly arrows originate either from a lone pair of electrons or from a bond. Full marks for a mechanism are unlikely to be awarded if there is uncertainty about the precision of the curly arrows.

### SECTION A

#### *Question 1*

This question rarely produced full marks. In part (a), many correct answers were seen, but the organic formulas caused problems and the need to indicate that the catalyst was concentrated sulfuric or phosphoric acid was often missed. Candidates should be encouraged to use  $\text{CH}_3\text{CH}_2\text{OH}$  for ethanol and  $\text{H}_2\text{C}=\text{CH}_2$  for ethene. In part (b), incorrect equations with too much oxygen on the left-hand side or those which used carbon monoxide, rather than carbon, were the most common errors.

#### *Question 2*

This question usually yielded at least half marks for most candidates. The equation in part (a) was done well and the mechanism in part (b) (i) usually scored at least one mark. Part 2(b)(ii) was high-scoring with a wide of range of accepted responses. Most candidates had some appreciation of the strain in the 3-membered ring of epoxyethane and recognised the production of antifreeze. They were not always so effective in giving either a correct name or a correct structure for ethane-1,2-diol.

#### *Question 3*

This was a high scoring question with many scores of eight or more marks. In part (a) candidates were penalised if the radical dot was shown to be on the  $\text{CH}_3$  group, rather than as given in the question. In part (b) many equations gave hydrogen as the product rather than hydrogen bromide, suggesting that candidates had difficulty applying the information to a novel situation. Parts (c) and (d) (i) were frequently correct, although the failure to number all of the substituents on the two carbon atoms of halothane was penalised. In part (d) (ii), many candidates had problems

using the data to calculate a correct relative molecular mass and the answer of 197.4 was the only response accepted. In part (d) (iii), consequential credit was awarded, with correct answers to either 3 or 4 significant figures being accepted.

#### ***Question 4***

This question was a challenge to many candidates, although answers with full marks were seen. In part (a), the definition caused problems for some. There was a lack of clarity for the second marking point which required a simple statement that structural isomers have different structural formulas. In the chemical tests, it was not considered appropriate to award credit to candidates who gave some observations but either no reagent or a completely incorrect reagent. Candidates should be encouraged to learn the reagents and to write whole reagents in questions of this type. If the attempt at a reagent looked like a plausible effort towards a known method for distinguishing the pair of isomers, such as the use of “dichromate”, rather than “acidified potassium dichromate”, the reagent was penalised, but credit was awarded for correct observations. This credit was withheld, however, if the candidate gave an identical result for both isomers and the answer “nothing” was penalised on the first occasion that it was given for a negative result. It is important for candidates to appreciate that the word “observations” means exactly what it says and that these are often colour changes or precipitate formation. In this context, it is worth noting that “clear” is not synonymous with “colourless”.

#### ***Question 5***

This was quite a demanding question on which only the higher achieving candidates were able to score high marks. Correct answers for part (a) (i) were seen quite often. In part (a) (ii), many candidates could draw the isomeric ketone, but were unable to draw the isomeric aldehyde often drawing one from the table. In part (b), pentanoic acid was usually drawn and named correctly, but the equation, which required [O] on the left-hand side to be balanced, was not always completed correctly. The fact that pentan-1-ol was a primary alcohol was well known, but the name often missed the necessary numbering for the alcohol functional group.

### **SECTION B**

#### ***Question 6***

This was a high-scoring question, with most of the marks coming from mechanisms. In part (a) the need to recognise that free-radicals are formed by homolysis or by breaking a C-C or C-H bond was not always included in the answer and if candidates referred to carbocations, this was treated as a chemical error for this two-mark section. The mechanisms in parts (b) and (c) were done well by many candidates, although the usual errors, including a negative charge on ammonia and a positive charge on the carbon of the C-Br bond, were seen. Part (d) proved particularly challenging. Very few candidates named poly(propene) correctly and even fewer recognised that the polymer is a long chained molecule. The idea that addition polymers of this type are solids at room temperature due to a great many weak intermolecular forces of attraction was not well understood. Many candidates referred to Van der Waals forces of attraction as strong forces or as strong bonds and several referred to the need to break strong covalent bonds. Answers to part (e) usually gained one of the two marks, although the idea that a nucleophile is an electron pair donor or a species capable of using its electron pair to form a co-ordinate/covalent bond was not well known.

## CHM3/P

### General Comments

This examination discriminated effectively between able and less able candidates. Many good scripts were seen, but relatively few candidates scored very high marks. The great majority of candidates scored at least half marks. Candidates found this year's paper as accessible as the paper in Summer 2005 but some aspects of the Planning exercise seemed to be unfamiliar to many candidates.

#### *Exercise One      Skill 2 Implementing*

This was one of the easier exercises on the paper. Many candidates scored high marks, with a significant number scoring full marks. The great majority of candidates scored the marks for *manipulative skills* and *completing the table*. Most candidates also scored the mark awarded for *precision of recording*.

The examiners corrected the starting temperature when the candidate's reagents had different initial temperatures, and then recalculated the temperature rise from the candidate's graph. This again worked smoothly, although a small number of centres failed to provide supervisor results. As expected, the *accuracy* of the candidates' results varied quite widely, but the majority of candidates scored at least one of the four marks. Where necessary the examiner re-plotted a candidate's graph and based the accuracy marks on the correct plot.

#### *Exercise One      Skill 3 Analysing*

Most candidates scored at least one of the two marks for plotting a graph of their results. However many candidates used an inappropriate temperature scale, losing one mark automatically. Some candidates were unfamiliar with a cooling curve and could not extrapolate their graph correctly. A small minority of candidates chose at least one awkward scale, and consequently often failed to plot the points correctly.

#### *Exercise Two      Skill 3 Analysing and Skill 4 Evaluating*

This exercise differentiated markedly between able and less able candidates.

In the **Analysing** section there were relatively few candidates who could not draw the appropriate best fit line on the graph. These candidates did not realise that the best fit line needed to pass through the origin. The great majority of candidates could obtain a volume from the graph in part 2 and were familiar with the ideal gas equation in part 3. The calculation of the  $M_r$  of the gas in part 4 defeated all but the better candidates. Far too many candidates used inappropriate units in the ideal gas equation and obtained unrealistic answers. Credit was not allowed to those who introduced without explanation a multiplying factor to bring their answer in line with that given in part 2 of the Evaluation.

As in previous years, many candidates could not record their answers with an appropriate *precision*. Although most students recorded the volume in part 2 as a whole number or to one decimal place, the need to record the  $M_r$  in part 4 to one decimal place was ignored by many

candidates. The great majority of candidates scored the mark for the *estimation of errors* in part 5.

A small number of candidates failed to score the mark for *nomenclature and terminology*. Candidates are expected to explain calculations **in full**, lay their work out logically and clearly, and use the appropriate terminology correctly. Units must be used correctly.

The **Evaluating** section of Exercise 2 proved once again to be a difficult part of the paper. In part 1 most of the candidates who plotted the graph correctly made an appropriate comment on the technique used. As in previous years a significant number of candidates could not calculate the *percentage error in the experiment* in part 2. In part 3, only the most able candidates gave a worthwhile answer in sufficient detail. Too many candidates suggested vague improvements such as “use a better thermometer” or “use a better balance” which did not receive credit. In part 4 many candidates did not appreciate that the smaller volume produced would result in a larger value for the  $M_r$ .

### ***Exercise Three Skill 1 Planning***

This exercise proved to be the most difficult part of the paper. Many candidates ignored the instructions and described a titration rather than the preparation of the solution.

Once again a disappointingly large number of candidates could not justify their chosen *scale*, often choosing  $0.1 \text{ mol dm}^{-3}$  as a suitable metal carbonate concentration. A number appreciated the 2:1 reaction ratio but then opted for a  $0.2 \text{ mol dm}^{-3}$  concentration. Many candidates were unfamiliar with the basic *method* required, and lost marks because they could not provide the necessary detail. The *colour change* at the endpoint was usually given correctly. In the treatment of *results*, most candidates showed some knowledge of the basic concepts but could not explain their volumetric calculation properly. Instead of using the data available they made rather vague, general comments such as “use the titration results to calculate the number of moles of acid used”. Virtually every candidate scored one of the *safety* points although a significant number lost credit by making no effort to link hazard to safety precaution.

## CHM3/C

### General Comments

Centres are to be warmly congratulated for their excellent and much appreciated efforts in ensuring that the moderation scheme ran smoothly and successfully once again. The standard of marking and the application of the appropriate criteria continue to be very good for the great majority of centres, and as a result few adjustments were necessary during the moderation process. The presentation and annotation of candidates' work generally remains at an excellent standard. The superb work done by most centres in this regard is greatly appreciated by moderators.

The very great majority of centres continue to use the exemplar material provided by AQA and most centres have moved to the new version<sup>1</sup>. Centres are once again reminded that ***this new version has superseded the original version***. Centres **must** use the new exemplar material for their assessment work if they are to meet the current assessment criteria in full. Centres are strongly advised to contact AQA if they need a copy of the new material.

The marks awarded covered a very similar range to those awarded in June 2004. Some centres continued to have most difficulties in Skill 4. The most frequent reason for the recommendation of a mark adjustment was that the coursework exercises used were insufficiently demanding.

A small number of centres continue to have difficulty with the scheme, and consequently received lengthy feedback forms. Happily many centres have acted on advice given in previous feedback, and consequently have escaped a mark adjustment. With apologies to regular readers, the following points are once again brought to the attention of teachers:

- A number of centres use their own exercises for assessment with great success. Problems which do arise usually result from the demand level of the exercise being inadequate, or the centre not providing the candidate with enough information in the student instruction sheet to allow them to fulfil the criteria for full marks. If an exercise is only worth a maximum of 6 marks, then the overall marks of all candidates using this exercise will be adjusted. Any centre planning to produce their own practical exercise or modify an existing exercise is very strongly advised to submit a copy to their coursework adviser **before** using the exercise.
- Major problems arise when centres modify the exemplar marking schemes. The modifications almost always reduce the demand level of the exercise by removing some of the more difficult scoring points without replacing them with appropriate alternatives. This inevitably reduces the maximum mark available. Sometimes the centre ignores the deliberate sectioning of the Exemplar mark scheme. Instead all scoring points are lumped together and a simple, often rather generous, sliding scale is applied. In either case, the final mark awarded is all too often too generous. In such cases the overall marks of all candidates using this exercise will be adjusted.
- Happily very few centres used exercises from recent AQA CHM3/P and CHM6/P practical examinations. New centres are reminded that such exercises do **not** give access to maximum

---

<sup>1</sup> Guidance for Practical Work Exemplar Assessment Material: Spring 2004 Onwards

marks if used for assessing coursework. The demand level of the exercises has been reduced to allow them to fit into the very short time available. Moderators are instructed to re-mark the exercises to a mark scheme which reflects the lower maximum mark available, and adjust the overall marks accordingly. Centres must not use examination exercises unless they restrict the maximum mark available to the candidate.

- A number of centres still persist in using an Sc1 approach despite very frequent warnings of its unsuitability. Centres are once again reminded that **an Sc1 style exercise does not meet the current criteria**. When an exercise is used to assess several skills, the candidate must write a complete plan **before** the practical work begins. There is no need for candidates to write a long history of the experiment; the aim is to provide a working practical plan. Scale cannot be justified by trial experiments; it **must** be justified by calculations. If the exercise does not lend itself to this type of justification then it is very unlikely that the plan will allow access to 8 marks. Where appropriate the candidate may use hypothetical results, but the candidate must **not** use their own experimental results in the plan. The scale section and the use of results sections must be separate; one calculation section cannot earn the marks for both. The candidate's work for each of the four skills must be submitted as distinctly separate items. **An Sc1 exercise is almost certain to receive a significant mark reduction.**
- Evidence suggests that a few centres continue to carry out assessments without proper supervision. In addition to the potential problems of collusion and plagiarism, some candidates produce very long word processed scripts, with much background research, passages from books, and downloads from the Internet. Centres must not credit such material. Instead the centre, like the moderator, should consider whether candidates with access to such information sources are receiving too much guidance, and limit the maximum mark available. **If an exercise is not carried out under direct supervision, the candidates' work should be annotated accordingly.**

A plan review, as allowed under the legacy syllabus, constitutes significant guidance, and limits the maximum mark available.

Centres are reminded that it is our expectation that candidates will complete the AQA Exemplar exercises under supervision and without access to notes, text books, the Internet, group discussion with other students or teacher prompt sheets. Candidates who make use of specimen answers, obtained from the teacher or the Internet, during the actual completion of the exercise are receiving too much guidance, and the maximum mark available **must** be reduced.

- Care should be taken with the use of ICT. Candidates should avoid downloading irrelevant information from the internet or CD ROM and using spreadsheets without any thought to the precision of recording. If ICT is used by candidates to calculate quantitative results, there needs to be clear evidence that the candidate can calculate the outcome independently and can arrive at a judgement of the errors.
- Happily very few candidates failed to fulfil the minimum requirement of submitting work taken from **at least two modules**. Centres are reminded that the work submitted must cover at least two modules, and the candidate's marks which count towards the total cannot be taken from just one module. If a candidate submits one mark per skill only, and all of the work is drawn from CHM1, the candidate will lose the lowest of the four marks.

- A number of centres still give a zero score when the candidate had in fact made a little progress. Centres are reminded that for any skill a score of 0 should only be awarded when a candidate submits **no useful work at all**. If the candidate gains a few of the scoring points 1 mark must be awarded.

### ***Skill 1 Planning***

The standard of work seen was generally high. The sections on scale and use of results continue to be the most demanding, with only the better candidates scoring highly in these areas. Centres are reminded that they must not dilute the demand in these difficult areas if the candidate is to have access to the highest marks. Too many centres allow candidates full marks for a scale which is not justified from the available data. In a thermochemistry exercise the candidate must use the likely enthalpy change to deduce appropriate reagent concentrations. The sections on justification of scale and use of results have to be treated separately; one set of calculations **cannot** count for both.

When centres use AQA Exemplar material they can only award full marks if the justification of scale is complete. Excellent answers to other parts of the script cannot compensate for an incomplete justification of scale. Centres writing their own planning exercises must ensure that the section on justification of scale is sufficiently demanding. The AQA Exemplar material should be used to provide the expected level.

Safety considerations are still not always specific to the exercise in question. To earn the safety mark candidates **must** consider the dangers posed by the reagents and products in the experiment, and suggest appropriate precautions. Simply giving a list of standard precautions does **not** merit the awarding of the safety mark.

### ***Skill 2 Implementing***

In general the standard of work seen was good, and most centres used tick lists well and placed a suitable emphasis on accuracy. The moderator panel is again very pleased to report that there is much good quality practical work being done by students.

Centres are reminded that it is impossible to award marks for recording and precision if the candidates do not **record** some results in an appropriate form of **their own design**. Some evidence, such as a tick list, of the candidate's performance in the manipulative skills section must be provided.

In far too many cases a target value was still not provided by the supervisor. In such cases, where the accuracy of the candidate's result cannot be assessed with confidence, the moderator will adjust the final marks of the candidates to **a maximum of 5**.

Many centres continue to have problems with Exemplar exercise 5, *The Relative Strength of an Unknown Acid*. Teachers often use a class average for the enthalpy change without checking that the candidate's calculated results are correct. The supervisor **must** ensure that:

- (a) the candidate has plotted the graph and extrapolated correctly. If this is clearly not the case, the supervisor must plot the graph and base the candidate's marks for accuracy **on the correct plot**
- (b) any differences in the initial temperatures of the reagents are taken into account when calculating the temperature rise
- (c) the candidate has calculated the enthalpy change correctly.

The majority of centres using this exercise did not make any allowance for a difference in initial temperatures of acid and alkali. When the centre based the mark for accuracy on a class average, this resulted in the moderator spending a considerable amount of time recalculating the enthalpy change values for each candidate. The marks for accuracy were then re-awarded and the candidates' overall marks were adjusted appropriately. Some candidates did not record both initial temperatures, casting grave doubt on the fairness of any class average value.

**Centres are once again asked to make sure that any variations in the initial temperatures of the two reagents are taken into account when awarding marks for accuracy, and that the candidate's graph has been plotted correctly.**

### *Skill 3 Analysing*

The standard exercises were again usually well presented and error analysis was covered very well. Difficulties arose in one or two familiar areas:

#### *Precision of recording*

Some centres are still unduly lenient when awarding this mark. Centres are reminded that recording with appropriate precision is absolutely essential if a script is to be given full marks.

#### *Graphs*

Centres are reminded that full marks cannot be awarded for a graph with a poor scale, which does not cover at least half of the graph paper or an incorrect extrapolation. If either of these faults are present the candidate can only be awarded a **maximum of one mark** out of two.

### *Skill 4 Evaluating*

Evaluation was once again the weakest area in terms of the level achieved in the candidates' scripts and the marking of the work. Unhappily, despite repeated warnings, a number of centres still used old versions of the Skill 4 exercises. Candidates then answered at great length without making specific reference to the data available in the **experiment as performed**. The candidates consequently struggled to reach a high level, mainly because they do not know what was expected rather than because of any lack of ability. Some centres tried to compensate for this by awarding marks on very flimsy evidence. Moderators are instructed to re-mark the evaluation according to the current mark scheme and adjust the overall marks accordingly.

A standard evaluation will require candidates to:

- (a) make a clear comment on the outcome of the experiment. Candidates are expected to identify any anomalous results and suggest a reason for the anomaly. An acceptable reason for an anomalous result must be in the nature of a "one off". *Heat loss* or *inaccurate equipment* are not acceptable reasons as they would potentially affect every result. Similarly the candidate is expected to suggest something more imaginative than "misread the apparatus". In a

volumetric exercise, *the first titration is a rough titration, use too much indicator or overshoot the endpoint* are possibilities. In a thermochemistry experiment *an incomplete reaction* for an early result, *inadequate stirring or taking the reading at the wrong time* are possibilities.

- (b) calculate the overall error of the experiment, and compare this with the apparatus error. If candidates have access to these errors they should be used to judge if the experiment has been any good or not! It is difficult for candidates to evaluate, say, a volumetric exercise whose results are very close to the target value. Centres must ensure that the candidates have a realistic target value for comparison. There must be a significant discrepancy between their results and the target.
- (c) identify the main limitations of **the exercise in question** and suggest remedies. Candidates must not present a long list of possible problems. The exercise itself must provide clear evidence of error and deficiency and candidates are expected to concentrate on these in their evaluation.

Centres must expect candidates to be able to appreciate the significance of results which are consistent but inaccurate. They should look for errors in a part of the exercise which would affect all results, or weaknesses in the method itself. Candidates cannot obtain full marks in this section if they simply focus entirely on improvements to the accuracy of measuring equipment.

The above notes are intended for that small minority of centres experiencing difficulty in meeting the coursework criteria. They must not be allowed to unduly detract from the very healthy overall picture. Given the pressures on centres to deliver the teaching programme, this was once again a very positive and encouraging session. Centres are again warmly commended for the trouble taken to assemble a sample which proved to be easy to moderate. Their efforts continue to be much appreciated by the moderator team.

## CHM4

### General Comments

This paper was found to be more accessible than the previous two. This is mainly due to some relatively easy marks in question 7 and also that the pH and gaseous equilibrium calculations were in structured questions in Section A. Although many candidates continue to score better on the physical aspects of the module, it is pleasing to note that the general standard of organic reaction mechanisms is improving. However the drawing of mechanisms continues to differentiate well between the candidates.

### Question 1

Good candidates were able to score high marks in this question.

The equation in part (a) was well answered; leaving out H<sub>2</sub>O was the most common error.

The mechanism in part (b) was well done by many, although several weaker candidates persist in writing a negative charge as well as a lone pair on nucleophiles such as methanol used here.

Incorrect structures for propanoic anhydride were common in part (c); many contained only three carbon atoms in total. By contrast, most candidates were able to answer part (d) correctly. In part (e)(i) many did not understand the meaning of the term “molecular formula” and wrote semi-structural formulae instead. However many correct structures were written in part (e)(ii).

### Question 2

In part (a) the changes were deduced well and although the explanations were less clear, marks on this part of the question were high. Part (b), however, differentiated well. This was particularly the case in part (b)(i) where only the best candidates correctly calculated the number of moles of HI. The expression for  $K_c$  in part (b)(ii) was well answered although a smaller number realised that the volume term cancelled in the expression because the numbers of moles of reactants and products were equal in the equation. Marks were gained in part (iv) for correct use of the data from part (i) and the better candidates were able to deduce that the answer to part (v) was the reciprocal of that to part (iv) although many repeated a  $K_c$  calculation.

### Question 3

Part (a) was a straightforward question and was answered well. High marks were also gained in part (b), although some candidates lost the mark in part (i) for the expression for  $K_a$  because they wrote the less general expression  $[H^+]^2/[HX]$  instead of  $[H^+][X^-]/[HX]$ . The calculation in part (ii) was usually well done. The mark in part (a)(iii) was awarded for a value of  $pK_a$  correctly calculated from their  $K_a$  in part (ii).

In part (c), only the most able realised that, because the reaction was between potassium hydroxide and sulphuric acid, the mole ratio of reactants was 2:1. Hence although the answers to part (c)(i) and (ii) were usually correct, very few gained the mark in part (iii). For many, this was their only error in part (b). Others however failed to use the total volume of solution, 48 cm<sup>3</sup>, correctly in calculating the concentration of hydroxide ions in part (iv) and/or were unable to use  $K_w$  or pOH to calculate the pH of the mixture. It was disappointing to see that a considerable number of candidates did not give the pH to two decimal places despite being asked to do so.

#### **Question 4**

Part (a)(i) was answered well by almost all candidates. In part (a)(ii) most were able to draw correct structures of the diol and the diacid but only the better candidates were able to name these molecules correctly. Even naming the relatively straightforward butan-2,3-diol caused problems. The dipeptides in part (b) were usually well drawn. In part (c) most candidates were able to draw the structure of a suitable halopropane in part (i), but many found the structure of the nitrile much harder.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NO}_2$  were common wrong answers. In part (iii), the first two parts were well answered, but relatively few candidates were able to draw the structure of a correct secondary or tertiary amine or a quaternary ammonium salt formed when propylamine reacts with an excess of halopropane.

#### **Question 5**

As usual with questions involving rate equations, this question was answered well, particularly parts (a) and (c). Part (b) however was poorly answered and only the very best candidates gained this mark. Many of the rest only divided the original rate by 2 instead of by 4 as the concentrations of both the ester and of  $\text{H}^+$  ions were halved. Again it was disappointing to see the number of candidates who did not give the pH to two decimal places despite being asked to do so.

#### **Question 6**

Part (a) was well answered and many candidates scored highly. The mechanism in part (b) proved more difficult and some candidates tried to use  $\text{BH}_4^-$  instead of  $\text{H}^-$  as expected. The name of the product proved very difficult for most candidates and many made no attempt to answer the question. In part (c), many confused Reaction 3, which is a dehydration or an elimination of water, with the removal of hydrogen from ethylbenzene using iron oxides.

#### **Question 7**

In part (a) most candidates were able to identify the absorption labelled **X** as due to the presence of the alcohol O–H bond and that labelled **Y** as due to the presence of the C=O bond. Yet many then drew a carboxylic acid or even an ester as a possible structure. An appreciable number failed to label one of their structures as A. Better candidates scored highly here.

Part (b) discriminated well. Better candidates were able to score (almost) full marks but weak candidates struggled to score more than a few marks. Many had difficulty with the structure of the three branched-chain C5 alkenes; unbranched alkenes were commonly given as were duplicates of a previous answer.

Only the better candidates were able to identify which dibromoalkane gave only three n.m.r. peaks and only the most able were able to deduce correctly the integration ratio and the splitting pattern of the three peaks.

## CHM5

### General Comments

The paper proved to be harder than the corresponding paper in June 2005. The mean mark of 62.0 was 7.3 marks lower than in June 2005 but the standard deviation of 24.1 was very similar to that in June 2005. The standard of work displayed by candidates was similar to that in 2005. There was no evidence to suggest that candidates had insufficient time to finish the paper.

### Question 1

This question discriminated effectively between candidates of differing abilities. Very able candidates scored well in all parts of the question except in parts (b) (ii) and (b)(iii). In part (a) a surprising number of candidates attempted to write an equation with the  $\text{Fe}^{2+}$  ion as a reactant instead of Fe. Answers to part (a)(ii) were usually correct. In part (a)(iii), many candidates incorrectly calculated the number of moles of iron by halving the number of moles of hydrogen. The method for calculating the mass of iron was usually correct but, although it was allowed, it was disappointing to note that candidates were using an  $A_r$  value of 56 for iron instead of the value of 55.8, given on the Periodic Table. Answers to part (a)(iv) usually used the correct method. Answers to part (b) (i) were almost always correct but the equations involving dichromate(VI) ions were only given correctly by the best candidates. Very few correct answers to part (b)(ii) were seen. The usual error was a failure to recognise that six moles of iron(II) ions react with one mole of dichromate(VI) ions. In part (b)(iii) most candidates did not recognise that chloride ions would be oxidised by manganate(VII) ions.

### Question 2

This question also produced a wide range of marks. A major misconception was to relate entropy directly to the energy of particles rather than to their disorder. Most candidates gave a correct answer to part (b). In part (c) weak candidates often discussed the breaking of bonds rather than referring to disorder. Others just reiterated the question by stating that the entropy would increase. Good candidates usually gained one mark by stating that the disorder of particles increases when a liquid changes to a gas but only the best candidates answered the question fully by referring also to the smaller change in order on melting. It was pleasing to note that part (d) was answered correctly by many candidates. Marks were sometimes lost when giving units in part (d)(iii) that did not tally with the numerical answer. For example, when the numerical answer should have corresponded to  $\text{J K}^{-1} \text{mol}^{-1}$  the units were frequently given as  $\text{kJ K}^{-1} \text{mol}^{-1}$ .

### Question 3

This question proved to be very difficult. In part (a), the identity of the gas **B**, carbon dioxide, was often the only correct answer. A carbonate or a charged species rather than a hydroxide were common errors for the precipitate, **A**, and only the very best candidates gave a correct equation. In part (b)(i) and (b)(ii) the reagent for Reaction 2 and the oxidation state of chromium were usually correct but the reagent and half-equation in part (b)(iii) were seldom correct. It was very pleasing to see many good diagrams in part (c) (i). Weaker candidates sometimes lost marks due to incorrect representations of the ligand often with missing hydrogens. In part (c)(ii) weaker candidates often did not answer the question; they did not refer to bonding. Other candidates usually gave one of the marking points but not both. In part (c)(iii) many candidates did not score

because they failed to mention entropy. A statement that the chelated complex was more stable was not enough to gain a mark. Parts (d) and (e) were not answered well and only the very best candidates gained full marks. The role of zinc was thought by most to be that of a catalyst. In part (e) many candidates, again, did not appear to read the question carefully and often gave inorganic rather than organic compounds. Another common error was to give formulae for propanal and propanoic acid rather than for ethanal and ethanoic acid.

#### **Question 4**

Good candidates were able to score high marks for this question. In part (a)(i) some weaker candidates gave an expression for  $K_c$  rather than for  $K_p$ . In part (a)(ii) a very common error was to give the partial pressure of **X** as 3.0 MPa, half of **Z**. The partial pressure of **Y** was then given as 9 MPa. Such answers were awarded only one out of three marks for recognising that the pressure of **Y** should be three times that of **X**. Consequential marking was adopted for part (a)(iii) and answers usually gained both marks though it was surprising to find that a candidate sometimes only squared the partial pressure of **Y** even though the same candidate had shown the pressure of **Y** cubed in part (a)(i). In part (b) the extra cost of using a high pressure was more often given than the disadvantage of a lower reaction rate.

#### **Question 5**

This question discriminated very effectively between candidates. In part (a) weak candidates were confused about reducing and oxidising agents. These agents were confused with the species that could be reduced and oxidised. Thus for part (a)(i)  $\text{Fe}^{3+}$  was a very common wrong answer and for part (a)(ii) the  $\text{F}^-$  ion was often suggested. Similarly in part (a)(iii) species were often incorrectly chosen from the left-hand side of the redox half-equations. Parts (b)(i) and (b)(ii) were usually correct but candidates were less successful with part (b)(iii). About half of all candidates gave the incorrect answer, an increase in the concentration of  $\text{Fe}^{3+}$  ions. For those candidates who gave a correct change in concentration only the best gained two marks for the explanation. Most omitted to mention that the electrode potential of the  $\text{Fe}^{3+}/\text{Fe}^{2+}$  electrode would be reduced.

#### **Question 6**

This question proved to be the most accessible of the four questions in Section B. Most candidates gave correct answers for part (a)(i). In Part (a)(ii), however, most candidates scored only the one mark for recognising that a Lewis base is an electron pair donor. The equation for the reaction of  $\text{NH}_3$  with  $\text{BF}_3$  was usually incorrect with various incorrect ionic products. Even when the equation was correct, only the very best candidates drew a correct shape for the  $\text{H}_3\text{NBF}_3$  product. The mechanism of the acylation reaction in part (b) was usually accurate and complete but few candidates were able to name the amide product correctly. Part (c) was not answered well except by the best candidates. Many weaker candidates appeared to be confused with addition to an alkene and referred incorrectly to the stability of primary and secondary carbocations. In part (d) many correct answers were seen. A common mistake was to show the formation of  $\text{H}^+$  ions instead of hydrogen. In part (e) most candidates gained one mark for mentioning van der Waals' forces between methane molecules and another mark for hydrogen bonding in water but many candidates did not recognise that there is hydrogen bonding in ammonia and only a very few candidates were able to explain why hydrogen bonding is more extensive in water than in ammonia.

**Question 7**

The general standard of answers to this question was disappointing. In part (a) many candidates lost marks because of contradictions in their answers. Typically magnesium chloride was stated to be ionic and then candidates went on to talk about the strong attraction between molecules of  $\text{MgCl}_2$ . An answer of this sort was regarded by the examiners not as a slip but as evidence of a lack of understanding. In a similar fashion some candidates incorrectly referred to silicon tetrachloride as a macromolecule with weak (covalent) bonds between molecules. In part (b) only the best candidates gave correct answers in terms of the electrostatic attraction between ions with the  $\text{O}^{2-}$  ion being attracted more strongly than the singly charged chloride ion. Many candidates referred incorrectly to the polarity of (covalent) bonds even when the same candidates had correctly identified  $\text{MgCl}_2$  as ionic in part (a). In part (c) the majority of candidates gave correct equations and pH values for the resulting solutions though a correct equation for  $\text{MgO}$  was less common than for  $\text{SO}_2$ . Only a very small number of candidates were able to describe what happens or what would be observed when these oxides are added to water. Part (d) proved to be very difficult. Candidates who attempted simple equations starting from  $\text{Al}(\text{OH})_3$  were often successful but others who started with  $\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3$  had more difficulty with charges on the aluminium species and with balancing equations. Many weak candidates attempted, incorrectly, to write equations starting with  $\text{Al}_2\text{O}_3$ .

**Question 8**

In part (a) only about half of candidates knew that the reducing power of the halide ions **increases** from  $\text{Cl}^-$  to  $\text{I}^-$ . Most candidates appeared not to have read this part of the question carefully enough to recognise that only reduction products were required. Candidates usually attempted to list all possible products from the reaction of sodium iodide with concentrated sulphuric acid. Marks were lost for giving products other than  $\text{SO}_2$ ,  $\text{S}$  and  $\text{H}_2\text{S}$ . Only the best candidates were able to give a correct equation for a redox reaction between  $\text{NaI}$  and  $\text{H}_2\text{SO}_4$ . In part (b) many candidates attempted an incorrect mechanism involving ions. When a correct free radical mechanism was shown it was very common for the second propagation step to be incorrectly shown as a termination step. Part (c) proved to be much easier than parts (a) and (b) and answers often gained all five marks. In some cases the third mechanism mark was lost because the curly arrow did not extend into the benzene ring, showing reformation of the delocalised ring of electrons.

**Question 9**

Part (a) of this question proved to be very difficult, especially the equations showing the overall reaction and the involvement of the  $\text{Mn}^{2+}$  and  $\text{Mn}^{3+}$  ions as an autocatalyst. Equations were usually attempted but did not balance in moles and in charge. Many candidates were not able to explain why, in the absence of a catalyst, the reaction is slow. Candidates were expected to recognise that the reacting, negative ions would repel each other. Answers to part (b) were much more accurate, almost always scoring at least three out of four marks. The mark lost was usually for an incorrect example or an omission of a specific example. The most frequent error was to suggest that sulphur poisons the catalytic converter in the exhaust system of a motor-car.

## **CHM6/W Synoptic Assessment**

### **General Comments**

This objective paper had a mean mark of 25.2, exactly one mark higher than the June 2005 paper. The mean facility now stands at 63% having risen steadily over the past three years. Notably, the improvement from pre-test scores was much improved in 2006, with an increase of 16% from the pre-test facility of 47%. This is in comparison to a 13% increase in 2005.

Questions 2,5,7,8,10,11,13,15,17,20,22,25,28,31,36 and 38 proved to be easy with a facility greater than 65%.

There were no questions with a facility of less than 35%.

All the questions in the paper discriminated well between candidates of differing abilities.

## CHM6/P

### General Comments

This examination discriminated effectively between able and less able candidates. High marks seemed harder to come by than in last year's examination, but the great majority of candidates scored at least half marks.

#### *Exercise One Skill 2 Implementing*

This was again one of the easier exercises on the paper. As is expected for an observational exercise, many candidates scored high marks, although relatively few candidates scored full marks. The great majority of candidates scored the marks for *manipulative skills* and *completing the table*, as well as obtaining at least half of the observations. Few centres appeared to have experienced problems in the preparation of the reagent solutions and the number of unexpected supervisor results was pleasingly low. As in previous years markers are instructed to credit candidates who match these results as long as they are reasonable.

The markers were very pleased to note that only a very small minority of candidates seemed unfamiliar with standard terminology. Candidates should be reminded that at A2 level they are expected to use appropriate terminology in reporting results. "Cloudy" and "clear" are not acceptable alternatives to "precipitate" and "colourless".

#### *Exercise Two Skill 3 Analysing and Skill 4 Evaluating*

This exercise differentiated well between able and less able candidates. There were many very good answers to the Analysing section but full marks were very rare in the Evaluating section.

In the **Analysing** section the majority of candidates were very familiar with a manganate(VII) redox calculation. The great majority of candidates could balance the equation in part 1, but some lost the mark because they did not cancel the hydrogen ions. Virtually all candidates could calculate a mean titre correctly in part 2, and use the equation and the mean titre to calculate a number of moles of hydrogen peroxide in part 3. As expected the weaker candidates could not apply the double scaling factor to calculate a molarity in part 4. Most candidates could calculate a value for the concentration in part 5 if they had obtained answers to parts 3 and 4. A surprising number of able candidates did not pay sufficient regard to *precision of recording*, especially in part 5. The *errors* section in part 6 was well answered and most candidates scored the mark for *nomenclature and terminology*. The usual omission was failing to explain the calculations in full. Overall candidates found this part of the examination straightforward and very low marks were rare.

The **Evaluating** section of Exercise 2 also proved to be straightforward but full marks were rare. In part 1, while most candidates made a relevant comment on the reliability of the titration results, a considerable number failed to clearly identify the first titration as a rough one, or state unambiguously that titres 2, 3 and 4 were concordant. Most candidates could calculate the percentage error in the experiment in part 2, but a few lost the mark because they did not show all of their working. In part 3 most candidates appreciated that this error was larger than the apparatus error but many did not appreciate the significance of this. At A2 level the candidate is expected to realise that a procedural error or an operator error must have occurred. Part 4 was answered very poorly. Only the better candidates took the hint given in the rubric that hydrogen

peroxide decomposes on standing. In search for a second reason even the best candidates often ignored the significance of a consistent set of titres delivering a very low result. Too many gave answers that would not have affected every titre.

### ***Exercise Three Skill 1 Planning***

For the first time the Planning exercise involved the measurement of a reaction rate. Given the popularity of this type of exercise for Sc1 coursework at GCSE it was hoped that the exercise would be familiar to most candidates. Judging by the scripts this did not appear to be the case. Although most candidates scored at least half marks, there were few good answers. It would appear that candidates had little first hand experience of this type of experiment.

Once again a disappointingly large number of candidates could not fully justify their chosen *scale*. Most candidates could suggest a sensible volume of gas to be collected but few could use the gas equation and the mole concept to deduce a suitable volume of the reagent solution.

The great majority of candidates managed to select and use appropriate *apparatus*; the usual omission was the apparatus needed to measure the appropriate volume of solution. Similarly the great majority of candidates were familiar with the basic *method* required, but many did little more than restate the information given in the introduction. Many candidates did not appreciate that when water is a reagent the use of a  $0.1 \text{ mol dm}^{-3}$  solution provides all the water needed for reaction. Candidates who added water were not penalised as long as the method described was workable. Of those candidate who appreciated that experiments with at least two concentrations would be needed, many chose a higher concentration for their second run. Many candidates described a second experiment with the same concentration but at a higher temperature.

In the treatment of *results*, far too many candidates could not clearly explain how to use the results from their experiments to confirm a first order reaction. Sketch graphs of volume against time were often presented but many candidates gave very vague instructions as to determining a rate from the graph. Of those candidates who had opted to measure the time taken to collect a given volume of gas, many did not use these volumes and times to calculate a rate. Candidates who merely stated the first order relationship, without a clear link to their data, were not credited.

Virtually every candidate could list the *safety* points but again too many made no attempt to link hazard to safety precaution and therefore lost credit.

## CHM6/C

### General Comments

Centres are once again to be congratulated for their efforts in ensuring that the assessment scheme continues to run very smoothly and successfully. The standard of marking and the application of the appropriate criteria were usually very good, and as a result few adjustments were necessary during the moderation process.

The very great majority of centres continue to use the exemplar material provided by AQA and most centres have moved to the new version<sup>2</sup>. Centres are once again reminded that ***this new version has superseded the original version***. Centres **must** use the new exemplar material for their assessment work if they are to meet the current assessment criteria in full. Centres are strongly advised to contact AQA if they need a copy of the new material.

The marks awarded covered a very similar range to those awarded in June 2005. As in CHM3/C the most frequent reason for the recommendation of a mark adjustment was that the coursework exercises used were insufficiently demanding.

A small minority of centres continued to experience sadly familiar difficulties in meeting the requirements of the scheme. Fuller details are given in the report for Unit 3(b). Rather than repeat the long list of recommendations here, this report will concentrate on aspects which are particularly relevant to Unit 6(b).

- There are still a few centres using experiments based on exercises from the legacy exemplar books.<sup>3</sup> The criteria for the new scheme do not match the criteria for the legacy syllabus. Some of these old exercises can be successfully adapted, some can not. Once again when a centre used legacy exercises and marking schemes without appropriate change a downward adjustment of marks was invariably recommended.
- Centres are once again reminded that it is our expectation that candidates will complete the AQA Exemplar exercises under supervision and without access to notes, text books, the Internet, group discussion with other students or teacher prompt sheets. Candidates who make use of specimen answers, obtained from the teacher or the Internet, during the actual completion of the exercise are receiving too much guidance, and the maximum mark available **must** be reduced.

Supervisors **should** help a candidate who is in difficulty, and apply a suitable penalty if the help is significant. This is the only guidance candidates should receive.

- Centres are reminded that exercise submitted for AS cannot be re-submitted for A2, even when the exercise is of an appropriate standard.

---

<sup>2</sup> Guidance for Practical Work Exemplar Assessment Material: Spring 2004 Onwards

<sup>3</sup> Exemplar Assessment Material for Practical Work (Issued November 1996 and February 1999)

### ***Skill 1 Planning***

Much good work was seen once again but the points made last year are worth repeating:

In Exemplar Exercise 19, *The Analysis of Lawnsand*, to score 8 marks the candidate **must** filter the mixture, with appropriate washing of the sand, when preparing a standard solution. Many candidates omitted this vital step, without penalty. Similarly, in the *justification of scale* section the candidates **must** calculate a scale for the acid as well as the sand. In the *use of results* section of this exercise candidates calculating a percentage of iron(II) sulphate, rather than iron as required, **must** lose the mark for this section.

Exercises taken from other Examination Boards or from text books almost invariably fail to match all of the AQA requirements, particularly in respect to justification of scale, safety and overall demand level. Any centre planning to use one of their own exercises is very strongly advised to submit a copy to their coursework adviser **before** using the exercise.

### ***Skill 2 Implementing***

In general the standard of work seen was very good, and most centres used tick lists well and placed a suitable emphasis on accuracy. Little inappropriate work was seen.

However, as in CHM3, too many centres failed to provide a target value. As at AS, where the accuracy of the candidate's result cannot be assessed with confidence, the maximum mark allowed by the moderator is 5.

Two exemplar exercises both require the plotting of a graph. Centres should take care not to reduce the demand level by allowing the candidates to plot a simpler graph or simply omit the graph section altogether.

Teachers often allocate marks for accuracy without checking that the candidate's calculated results are correct. The supervisor **must** ensure that

- (a) the candidate has plotted the graph and, in Exercise 20, extrapolated correctly. If this is clearly not the case, the supervisor must plot the graph and base the candidate's marks for accuracy **on the correct plot**
- (b) in Exercise 20 any differences in the initial temperatures of the reagents are taken into account when calculating the temperature rise
- (c) in Exercise 17 the candidate has drawn the line of best fit. If this is clearly not the case, the supervisor must draw the correct line of best fit and base the candidate's marks for accuracy **on the correct line**
- (c) the candidate has calculated the enthalpy change or order correctly.

In Exemplar exercise 20, *The Enthalpy of Decomposition of Sodium Hydrogencarbonate* centres are reminded that in this exercise the **target value given in the booklet is only a guide**. The supervisor should perform the experiment to obtain a meaningful target value for the candidates.

In Exemplar exercise 17, *The Reaction between Hydrogen Peroxide and Iodide Ions*, centres may assess accuracy on the correct order (1) or against a teacher value for the experiment. **In this one case centres must not use a class average.**

A number of centres used a manganate(VII) titration, usually with iron(II), for this skill. This is perfectly acceptable **as long as the exercise involves at least one weighing**.

### ***Skill 3 Analysing***

The standard exercises were usually well presented and error analysis was covered very well. In Exemplar Exercise 20, *The Decomposition of Sodium Hydrogencarbonate*, candidates were not penalised as they should have been for poor temperature scales, or completely erroneous extrapolations. If either of these faults are present the candidate can only be awarded a maximum of one mark out of two. Centres are also reminded that recording with appropriate precision is absolutely essential if a script is to be given full marks.

A small number of centres continue to use a manganate(VII) titration, usually with iron(II), for this skill. A redox titration is acceptable as long as the exercise presents more challenges than the volumetric exercises in CHM3/C. A simple calculation of molarity or  $M_r$  for perhaps the most familiar redox titration of them all is insufficiently demanding at this level and **cannot access 8 marks**. Such exercises are worth a maximum of 6 marks. Moderators are instructed to re-mark the coursework to a mark scheme which reflects the lower maximum mark available, and adjust the overall marks accordingly. The titration of an Fe(II)/Fe(III) mixture with dichromate(VI), the analysis of a mixture of ethanedioic acid and sodium ethanedioate or the dilution and titration of bench hydrogen peroxide with manganate(VII) are possibilities. However centres must **not** use exercises from CHM6/P practical examinations.

### ***Skill 4 Evaluating***

Evaluation was once again the weakest area in terms of the level achieved in the candidates' scripts and the marking of the work. Unhappily, despite repeated warnings, far too many centres still used old versions of the Skill 4 exercises. Candidates then answered at great length without making specific reference to the data available in the **experiment as performed**. The candidates consequently struggled to reach a high level, mainly because they do not know what was expected rather than because of any lack of ability. Some centres tried to compensate for this by awarding marks on very flimsy evidence. Moderators are instructed to re-mark the evaluation according to the current mark scheme and adjust the overall marks accordingly.

A standard evaluation will require candidates to:

- (a) make a clear comment on the outcome of the experiment. Candidates are expected to identify any anomalous results and suggest a reason for the anomaly. An acceptable reason for an anomalous result must be in the nature of a "one off". *Heat loss* or *inaccurate equipment* are not acceptable reasons as they would potentially affect every result. Similarly the candidate is expected to suggest something more imaginative than "misread the apparatus". In a volumetric exercise, *the first titration is a rough titration*, *use too much indicator* or *overshoot the endpoint* are possibilities. In a thermochemistry experiment *an incomplete reaction* for an early result, *inadequate stirring* or *taking the reading at the wrong time* are possibilities.
- (b) calculate the overall error of the experiment, and compare this with the apparatus error. If candidates have access to these errors they should be used to judge if the experiment has been any good or not! It is difficult for candidates to evaluate, say, a volumetric exercise whose results are very close to the target value. Centres must ensure that the candidates have

a realistic target value for comparison. There must be a significant discrepancy between their results and the target.

- (c) identify the main limitations of **the exercise in question** and suggest remedies. Candidates must not present a long list of possible problems. The exercise itself must provide clear evidence of error and deficiency and candidates are expected to concentrate on these in their evaluation.

Centres must expect candidates to be able to appreciate the significance of results which are consistent but inaccurate. They should look for errors in a part of the exercise which would affect all results, or weaknesses in the method itself. Candidates cannot obtain full marks in this section if they simply focus entirely on improvements to the accuracy of measuring equipment.

Given the pressures on centres to deliver the teaching programme, this was once again a very positive and encouraging session. Centres are again warmly commended for the trouble taken to assemble a sample which proved to be easy to moderate. Their efforts are much appreciated by the moderator team.

# Mark Ranges and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
CHM1	60	60	32.2	13.2
CHM2	60	60	31.5	13.4
CHM3/W Written	60	75	41.4	18.6
CHM3/C Coursework	30	45	36.3	6.3
CH3C	--	120	78.1	22.5
CHM3/W Written	60	75	41.3	18.6
CHM3/P Practical Exam	30	45	21.2	4.3
CH3P	--	120	73.5	23.3
CHM4	90	90	57.2	18.9
CHM5	120	120	62.0	24.1
CHM6/W (OTQ)	40	60	38.0	10.8
CHM6/C Coursework	30	30	25.5	3.4
CH6C	--	90	63.7	12.6
CHM6/W (OTQ)	40	60	38.0	10.8
CHM6/P Practical Exam	30	30	20.6	3.9
CH6P	--	90	58.7	13.7

For units which contain only one component, scaled marks are the same as raw marks.

**CHM1 Atomic Structure, Bonding and Periodicity (12515 candidates)**

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	60	44	38	32	26	21
Uniform Boundary Mark	90	72	63	54	45	36

**CHM2 Foundation Physical and Inorganic Chemistry (21343 candidates)**

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	60	43	37	31	25	19
Uniform Boundary Mark	90	72	63	54	45	36

**CH3C Introduction to Organic Chemistry with Coursework (14794 candidates)**

		Max. mark	A	B	C	D	E
CHM3/W Boundary Mark	raw	60	47	41	35	29	24
	scaled	75	59	51	44	36	30
CHM3/C Boundary Mark	raw	30	26	23	20	17	14
	scaled	45	39	35	30	26	21
CH3C Scaled Boundary Mark		120	98	86	74	62	51
CH3C Uniform Boundary Mark		120	96	84	72	60	48

**CH3P Introduction to Organic Chemistry with Practical Examination (5448 candidates)**

		Max. mark	A	B	C	D	E
CHM3/W Boundary Mark	raw	60	47	41	35	29	24
	scaled	75	59	51	44	36	30
CHM3/P Boundary Mark	raw	30	23	20	17	15	13
	scaled	45	35	30	26	23	20
CH3P Scaled Boundary Mark		120	93	82	71	60	50
CH3P Uniform Boundary Mark		120	96	84	72	60	48

**CHM4** Further Physical and Organic Chemistry (7021 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	90	72	64	56	48	40
Uniform Boundary Mark	90	72	63	54	45	36

**CHM5** Thermodynamics and Further Inorganic Chemistry (11185 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	120	85	73	62	51	40
Uniform Boundary Mark	120	96	84	72	60	48

**CH6C** Synoptic Assessment with Coursework (8727 candidates)

		Max. mark	A	B	C	D	E
CHM6/W Boundary Mark	raw	40	33	29	25	21	18
	scaled	60	50	44	38	32	27
CHM6/C Boundary Mark	raw	30	26	23	20	17	14
	scaled	30	26	23	20	17	14
CH6C Scaled Boundary Mark		90	76	67	58	49	41
CH6C Uniform Boundary Mark		90	72	63	54	45	36

**CH6P** Synoptic Assessment with Practical Examination (2406 candidates)

		Max. mark	A	B	C	D	E
CHM6/W Boundary Mark	raw	40	33	29	25	21	18
	scaled	60	50	44	38	32	27
CHM6/P Boundary Mark	raw	30	22	19	16	14	12
	scaled	30	22	19	16	14	12
CH6P Scaled Boundary Mark		90	72	63	55	47	39
CH6P Uniform Boundary Mark		90	72	63	54	45	36

## Advanced Subsidiary award

Provisional statistics for the award (13561 candidates)

	A	B	C	D	E
Cumulative %	21.7	38.7	55.1	71.0	84.8

## Advanced award

Provisional statistics for the award (10485 candidates)

	A	B	C	D	E
Cumulative %	32.5	56.8	75.2	88.6	96.7

## Definitions

**Boundary Mark:** the minimum mark required by a candidate to qualify for a given grade.

**Mean Mark:** is the sum of all candidates' marks divided by the number of candidates. In order to compare mean marks for different components, the mean mark (scaled) should be expressed as a percentage of the maximum mark (scaled).

**Standard Deviation:** a measure of the spread of candidates' marks. In most components, approximately two-thirds of all candidates lie in a range of plus or minus one standard deviation from the mean, and approximately 95% of all candidates lie in a range of plus or minus two standard deviations from the mean. In order to compare the standard deviations for different components, the standard deviation (scaled) should be expressed as a percentage of the maximum mark (scaled).

**Uniform Mark:** a score on a standard scale which indicates a candidate's performance. The lowest uniform mark for grade A is always 80% of the maximum uniform mark for the unit, similarly grade B is 70%, grade C is 60%, grade D is 50% and grade E is 40%. A candidate's total scaled mark for each unit is converted to a uniform mark and the uniform marks for the units which count towards the AS or A-level qualification are added in order to determine the candidate's overall grade.