

Chemistry B (Salters)

Advanced GCE A2 H435

Advanced Subsidiary GCE AS H035

Examiners' Reports

June 2011

HX35/R/11

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This report on the Examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the Examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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Chief Examiner's Report

It was clear once again this year that Salters candidates worked hard in the examinations to show what they understood and what they could do. Calculations showed improvement with many candidates explaining their working so that they could be awarded marks for 'error carried forward' if they made a mistake. Grasp of standard form was sometimes lacking in the first unit (F331) but seemed fine elsewhere. Organic chemistry was often done well, with candidates showing a sound understanding of the reactions concerned.

Answers on infrared spectroscopy were usually of a high standard.

Equation writing was done well by a minority of candidates, with others still finding it difficult, especially for organic reactions.

Some candidates were able to express themselves well in the longer answer questions, showing good understanding and the ability to express themselves well in chemical language. Others were less fluent. Their answers did not say what they meant and their use of chemical terms was hesitant. As ever, some failed to read and answer the question set and relied on memories of previous questions.

Paper setters try hard to provide enough lines for candidates, even those with large handwriting, to answer the questions in the space provided. They feel that it would be wrong to give inordinate numbers of lines, however, as this might unsettle well-organised candidates who answer the question in a concise way and then wonder what they should be writing on the surplus lines. Thus for some candidates there will always be a need to continue an answer elsewhere. Candidates should be briefed not to go outside the 'strip' of the part concerned (unless the question is the last on the page, when they can continue to the bottom of the page). They should use the lined pages at the back of the paper or, in their absence, additional sheets obtained from the invigilator. It is vital that candidates indicate in their answers when they are going on to such pages and also write the correct part number on the extra sheet.

Centres should be aware that from 2012 the Chemistry B (Salters) Data Sheet will be printed on pink paper, rather than blue paper. No changes have been made to the content of the Data Sheet.

F331: Chemistry for Life

General Comments

In common with recent papers there were a wide range of marks on this paper. Centres seem to have had candidates well-prepared for this paper and marks are commensurate with this preparation.

The addition of extra blank pages at the end of the paper proved useful, but candidates should be reminded that they must indicate they have used those pages by comments next to the appropriate question(s). Time was not an issue and there were few answers left blank.

Comments on Individual Questions

Question 1

(a)(i)

This easy starter was correctly answered by the vast majority of candidates and the follow up calculation in part (a)(ii) differentiated well across the ability range. The most common errors being the wrong value calculated for the bonds broken and a number of candidates omitted the sign of the enthalpy change. 'Ecf' marks could be obtained from a wrongly balanced equation and for the correct process being followed even when the bond terms had been wrongly calculated.

(a)(iii) was well answered, although some candidates discussed, wrongly, loss of fuel from the wick.

In (b) the majority of candidates correctly drew the required skeletal formulae and the calculation in (b)(ii) also presented no problems for most candidates.

(b)(iii) proved one of the most difficult questions on the paper, and it was indeed intended as a higher level question. Many candidates effectively repeated the information given i.e. 'propene has a higher percentage of carbon; the fuel with both propane and propene burns more yellow, therefore it's the carbon in the molecule burning that gives the yellow flame'. The marks, however, were for realising that the presence of the propene would lead to incomplete combustion of the fuel and that this would produce carbon solid/particulates/soot and it is this elemental carbon which causes the yellow flame.

(c)(i) produced many excellent diagrams. However some candidates unfortunately drew an ionic structure with cations and anions. Others labelled the metal cations as metal nuclei or metal atoms, none of these variations scoring.

(c)(ii) Many candidates gave the expected answer of '(quantised) electronic energy levels/shells', but wrong answer included just 'energy levels' or answers from previous questions in terms of the origin of emission spectra.

Question 2

(a) was another easy starting part and was well answered by most.

(b)(i) also produced many well-structured answers. Common mistakes included the use of magnetic fields and ions being accelerated to the same speed rather than the same kinetic energy.

(b)(ii) proved quite discriminating but by far the most common error was to mistake significant figures for decimal places.

In (c) some candidates built their whole answer around why calcium was more reactive than magnesium but all that was required to gain the marks was that they were in the same group and they therefore showed a similar chemistry (or both formed 2+ ions).

(d)(i) was well-answered with an ecf allowed on the value of z . The use of an alpha symbol did not score; this is because this is not a decay equation but a fusion reaction.

(d)(ii) proved straightforward, the most common mark missed was the idea of having to overcome the repulsion of the positively charged nuclei.

Question 3

(a)(i)

The dot-and-cross diagram was confidently answered by most, the omission of the lone pairs on the sulfur being the common error.

In (a)(ii) it was clear that some candidates were not confident with the use of scientific notation and powers of ten (see 'Tip for Centres' last session and repeated below), and only scored the mark for the correct M_r of methanethiol.

Tip for Centres

Try to persuade candidates to use calculators that have the facility to use scientific notation. This will certainly make it easier to deal with significant figures and very large or very small numbers.

(b)(i) was well-answered.

(b)(ii) produced, as ever, a range of answers depending on the ability of the candidate. The slight change in the way the question was phrased did not cause any problems for the more able candidates, who were able to produce an almost flawless answer and frequently, and sensibly, talked about groups of electrons, thus avoiding confusion with pairs of electrons particularly around the carbon at angle 'b'. Unfortunately examiners still reported the usual errors e.g. 'electrons repel as much as possible', 'atoms repel' and 'there are three pairs of electrons around the central carbon atom at 'b''.

(c) caused some difficulty for candidates. The first mark was for the suggestion that there are (relatively) large reserves/supplies of coal and this was scored rarely. Candidates had fewer problems with disadvantages, with the formation of sulfur oxides and/or the subsequent acid rain formation being the most commonly scored mark. Rather fewer candidates scored a second mark by commenting on the formation of smoke/particulates/ash. Smog, but not photochemical smog, was also allowed for the second mark.

The most common mistake in (d) was the use of the mass of coal instead of the mass of water when calculating the heat transfer, otherwise this question was competently tackled by most.

(e) raised a few issues for candidates. The key factor, the very different structure of sulfur compared to carbon, was often completely missed. Some candidates also talked in terms of boiling points which unfortunately negated the melting point mark. Only the most able candidates scored both marks on this question.

Question 4

Although all full questions on this paper showed good differentiation, question 4 overall produced the widest range of marks.

(a)(i) was correctly answered by a large majority, 'cycloalkane' being the most common incorrect answer.

(a)(ii) was generally well-answered.

In (b)(i) the more able candidates correctly suggested a lower temperature of combustion or less nitrogen in the tyres, however some candidates attempted answers in terms of the use of controlled conditions which almost inevitably did not score.

In (b)(ii) carbon monoxide was the correct answer given by a majority of candidates.

In (c)(i) the expected 'unsaturated' was given by a majority of candidates. However there was some confusion with isomerisation and this had a knock on effect for (c)(ii) and (iii), where the correct answers were, 'cycloalkane/arene' and 'hydrogen'.

(d)(i) yielded two marks for able candidates but there was still confusion over the role of a catalyst in the chemical language used by weaker candidates. For example, incorrect phrases used included 'not involved in the reaction' or 'reduces the activation energy'. The latter phrase needs 'offering a different mechanism or pathway' to score the mark.

Finally, (d)(ii) produced many virtual 'text book' answers. The most common error is still candidates not clearly stating what bonds are breaking in step two. This type of question has been asked on several occasions and candidates should by now be saying 'bonds within reactant molecules break'.

F332: Chemistry of Natural Resources

General Comments

There was a wide range of marks achieved by candidates for the paper as a whole, covering most of the available mark range. There was no indication that lower marks resulted from a lack of time, with answer spaces that were left blank being rare and resulting from a lack of knowledge or understanding of the question, rather than an inadequate amount of time.

Good attempts were made at most of the calculation questions, where many candidates set out their answers sufficiently clearly to be able to see what was being calculated at each stage, allowing credit to be given under the 'error carried forward' rules if a mistake had been made. Answers to the longer questions were often good, with candidates taking care with the use of technical language in their explanations. Questions requiring a chemical equation to be written were also well answered. Many candidates achieved good scores on question 5, showing they had used the advance notice article and prepared well for this part of the paper.

Answers to questions involving organic syntheses tended to produce lower marks, with a common error being incorrect reaction conditions. Answers requiring an explanation of information given in the question also tended to produce lower marks.

Comments on Individual Questions

Question 1

For many candidates, this was one of their lower-scoring questions.

- (a)
- Most candidates answered this correctly. Those candidates scoring one of the two marks often had not used an equilibrium symbol in their equation.
 - A minority of candidates gained the mark for a clearly worded answer. Many who did not score had incorrectly written that it was the oxidation state of the chloric(I) acid, rather than the chlorine in the chloric(I) acid.
 - Many candidates scored this mark.
- (b)
- A small proportion of candidates used the information given in the question to carry out the sequence of steps needed to work out a correct answer.
 - A good proportion of candidates scored all three marks for a clearly set out and well-explained answer. Many who did not gain full credit scored marks for showing they could work out oxidation states. Those not scoring at all often tried to use ideas of oxidation and reduction without using the concept of oxidation states.
 - Some candidates gained full credit by correctly analysing the information given in the question. Candidates who did not score marks often gave answers that lacked detail or that were not a comparison of the two chemicals.
- (c)
- This question was well answered, with many candidates scoring both marks and very few gaining no credit. Those who scored one mark had often left out the electrons or put them on the wrong side of the equation.
 - Many candidates scored this mark. Those who did not score had often left the volume in cm^3 rather than converting it to dm^3 .

- iii) Many candidates scored this mark by giving a correct numerical value. Other candidates scored because they made correct use of an incorrect answer from the previous question and gained credit under the 'error carried forward' rule.
 - iv) A significant number of candidates scored full credit here. For those scoring two of the three marks, the most common error was not giving their final answer to two significant figures.
- (d) A small proportion of candidates scored both marks. Those scoring one mark gave the outer sub-shell arrangement for iodine atoms, rather than iodide ions. Those candidates who did not score most often drew an electron shell diagram, rather than considering the arrangement of electrons in sub-shells.
- (e) Most candidates scored this mark.

Question 2

For many candidates, this was one of their highest scoring questions.

- (a)
- i) A small proportion of candidates correctly combined the sequence of reaction equations given in the question to work the overall equation. Those not scoring had often not cancelled out all species that appear on both sides of the combined equation.
 - ii) Many candidates gained full credit and few did not score at all. Those scoring one mark most often selected a correct particle but did not word their explanation of their choice sufficiently clearly to score the second mark.
 - iii) Most candidates scored this mark.
- (b)
- i) Most candidates answered this correctly.
 - ii) Most candidates gained some credit for giving at least one correct reagent. Many gained both reagent marks. Full marks were seen less often, mostly because the answer stated 'heat under reflux' as the reaction condition, rather than 'distil'.
 - iii) Many candidates gained two marks for stating that reaction rates increase and particles have more energy at higher temperatures. A small proportion of candidates went on to gain full marks for their additional explanation of why the increase in particles' energies caused the increase in rate.
 - iv) Many candidates gained credit here.
- (c) Most candidates scored at least three of the available marks. Answers were often well worded and technical terms were used appropriately. Many answers showed a detailed understanding of the processes occurring when uv radiation enters Earth's atmosphere and the potential dangers that are linked to this type of radiation. These answers often gained full credit. Those candidates whose marks were limited to three or fewer had often given too few details in the part of the answer related to the way that ozone forms in the atmosphere.

Question 3

For many candidates, marks on this question were lower than on others within the paper.

- (a) Most candidates scored at least one mark on this question. A small proportion of candidates gained full credit. It was most common that those scoring one mark gained credit for recognising the alkene group and those gaining both marks also included the ether group.

- (b) Most candidates scored full credit for their answer.
- (c)
- i) Most candidates scored here, with a significant number gaining full credit for carefully worded and detailed explanations of how hydrogen bonds form between water molecules. Those scoring two marks most often left the 'lone pairs on the oxygen of the water molecule' out of their answer.
 - iii) A small proportion of candidates used the information given in the question to work out and explain the reason for the low solubility of the eugenol in water, giving clearly worded and detailed answers.
- (d)
- i) Most candidates scored one mark for showing their understanding of the role of the C=C in the creation of isomers. A few candidates also knew that the second requirement was that the two carbons of the C=C both had two different groups attached to them and so gained both marks.
 - ii) A small percentage of candidates gained credit for identifying a suitable catalyst, with some going on to show they also knew the correct reaction conditions to use for their chosen metal.
 - iii) Some candidates scored marks for understanding that the reaction that was described in the question would chemically alter the C=C of the molecule. Those not gaining credit most often thought that the reaction involved substitution onto the benzene ring.
- (e)
- i) Most candidates scored here.
 - ii) Incorrect answers to this question were rare.
 - iii) Most candidates gained at least one mark.

Question 4

The quality of answers to this question was lower for most candidates than on the other questions.

- (a) A small percentage of candidates gained both marks for their answer. Most candidates did not score because their structure did not have a dative bond and the atoms electron shells were not full.
- (b)
- i) Most candidates scored this mark.
 - ii) Many candidates scored here.
 - iii) Many candidates calculated the atom economy correctly. Many of those who did not score had calculated an incorrect total mass for the products.
 - iv) A large minority of candidates gained this mark. Those who did not score often omitted comments on the atom economy from their answer.
- (c)
- i) Most candidates scored at least one mark, with many gaining both. Most scoring just one mark had correctly commented on the comparative rates of the forward and backward reactions.
 - ii) Most candidates scored here, with the majority gaining at least two marks. Many answers were well worded and used technical terms associated with equilibrium reactions correctly. Those candidates gaining little credit often did not use the term '(position of) equilibrium' in their answer.
 - iii) Most candidates gained at least one mark and many scored both. Those gaining only one mark often stated that the catalyst lowered the activation enthalpy, but did not say that it did this by providing an alternative reaction pathway, and so did not score the second mark.

- (d)
- i) A small proportion of candidates scored a mark here for a correct reagent, with a few going on to gain credit for reaction conditions as well. A common error from those who did not score on this question was to give chlorine as the reagent, instead of hydrogen chloride.
 - ii) Most candidates scored both marks. Those gaining one mark had often left the energy in units of kJ instead of converting to J.
 - iii) A large majority of candidates scored both marks.
 - iv) Most candidates gained some credit here, often for explaining how halogenoalkanes are broken down by uv light to produce halogen radicals.

Question 5

The quality of answers to this question was generally above those of the other questions, with answers showing that candidates had used the article to help them to prepare for this question in advance of the exam.

- (a) Most candidates gained credit here, with many scoring both marks. The most common reason for a candidate to score one mark was that they gave an example of a thermoplastic that had not been identified as such in the article.
- (b) Most candidates scored here.
- (c) Most candidates gained at least one mark, with many going on to score both. The most common correct reason given was that the vehicle would be lighter. Most candidates who scored only one mark, or did not score at all, gave reasons that were not based on information from the article.
- (d) Most candidates gained this mark.
- (e)
- i) The majority of candidates scored this mark.
 - ii) This mark was gained by a minority of candidates who correctly interpreted the explanation of the polymerisation reaction given in the article.
- (f)
- i) Most candidates scored here.
 - ii) This mark was gained by most candidates.
- (g)
- i) A small proportion of candidates scored this mark by writing a carefully worded explanation.
 - ii) Most candidates scored this mark.
- (h) A small minority of candidates gained this mark. Those who did not score did not make it clear that no second product forms.
- (i)
- i) Many candidates scored this mark.
 - ii) Most candidates scored full marks for their answer.
- (j) Most candidates gained at least one of the two marks. Those who did not score, or only gained one mark, often failed to give a use for the polymer that linked to their property and to explain why the property allowed the polymer to be used for this application.

F333: Chemistry in Practice

Organisation of work

Given that this was the third year of this assessment component, most Centres are now familiar with its' general demands. However, before undertaking assessment of practical skills it is recommended that teachers familiarise themselves with the **Practical Skills Handbook**.

Candidates' work was usually well organised and labelled. Candidates may of course attempt more than one Task from each Skill with the best mark from each Skill being used to make up the overall mark. To help track candidate marks it is recommended that Centres use the interactive Marks Spreadsheet that is available on Interchange, from the GCE Chemistry B (Salters) page. If used, Centres should send a copy to the Moderator along with the Mark Sheet (MS1).

Centres should group the candidate's four best Tasks together loosely (e.g. with a treasury tag) when submitting work to the moderator and also include a copy of the Skill I Competence Record Card (also available on Interchange). It should be noted that **only** the four best Tasks should be submitted for moderation and **not** all of the work that has been completed. Similarly if a candidate achieves the same score on two or three Tasks for a given Skill, the Centre must choose which Task to submit for moderation and not simply submit all to the moderator.

Conduct of Tasks

All Tasks used in the assessment of Skills II to V should be carried out under controlled conditions. Candidates are not allowed to modify or add to their answers after the Task has been handed in to their teacher. It should be rare, therefore, for candidates' work sent for moderation to include answers that have been crossed out and replaced.

Skill I

It is still the case that the expected documentation to support the award of marks for Skill I was not always included with the moderation sample. Centres should use the Competence Record Card available from OCR, or devise their own document, to show that the activities undertaken by candidates cover all of the six required types of practical work and to include marks or teacher comments noted during the year to help inform the award of marks for Skill I.

The mark for Skill I should be the best fit integer (whole number) when judged against the marking descriptors, so that when doubled a mark out of 12 is generated that is an even number. Some Centres are still giving a mark of say 5.5 and doubling this to give 11. This will give rise to a Clerical Error form being generated to the Centre.

The marks awarded to candidates by most Centres for Skill I showed the expected good match with marks gained by candidates in Skill II and Skill IV Tasks. This suggests that Centres are applying the descriptors for Skill I in an appropriate manner. This is of course to be expected since Skills I, II and IV all assess the ability of candidates to carry out practical work. However, some Centres are still giving what appear to be inflated marks for Skill I when compared with Skills II and IV.

Skills II-V

The marks awarded to candidates by centres for Skills II to V represented a generally accurate application of mark schemes to candidates' work. There were, however, a number of cases where candidate answers were marked as correct even though they did not match the expected answers given in the Mark Scheme.

In Skill II Tasks, there were few problems. The Mark Schemes give very precise guidance about what is required in tables of recorded data and the marks available for candidate results when compared to the value obtained by the teacher. Occasionally marks were awarded that were not consistent with this guidance. The main problems here occurred where subtractions of initial from final titres had not been checked in titrations. It is important that the Additional Guidance is carefully followed in such cases to see whether or not a mark may be awarded e.g. Tasks 1 and 2, parts (d)-(h), and Task 3, parts (d)-(g). Also when showing which readings have been used to calculate an average value for a titre, if requested a tick must be placed against the readings used if that mark is to be awarded. It should also be noted that in Task 3, part (h) it is important that candidates have extrapolated the cooling curve back to 5 minutes and clearly indicated that it is the temperature at this intersection point that is read off for the answer. Other lines can then be ignored.

In Skill III Tasks, the Mark Schemes allow for candidate errors made in one part of the Task to be carried forward to subsequent parts to avoid penalising the candidate twice for the same error. Not all Centres applied this idea effectively. Again the Additional Guidance helps with the award of marks. It should also be noted that in Task 3, part (f) the explanations 1 and 2 must correspond with the causes 1 and 2 in part (e). For example, if explanation 2 matches cause 1, no mark should be awarded.

The Mark Schemes in Skill IV Tasks often include precise observations that are expected in order for candidates to be awarded marks. In some cases marks were awarded even though the expected observations were not included or were very vague. For example, if the Mark Scheme requires candidates to observe that a blue precipitate is formed for 1 mark (Task 1, part (b)), then both colour and an indication of solid will be expected. Similarly if a precipitate dissolves then an answer that says that 'the solid sinks to the bottom of the test tube' and does not indicate that the amount of solid becomes less (Task 3, part (e)(ii)) should not be awarded a mark. Again if the Mark Scheme requires candidates to identify the formation of two layers in a test tube (Task 2, part (a), and Task 3, parts (b) and (c)) then this should be made explicit in the candidates' answer to gain a mark. So an answer such as 'orange at the top, colourless below' is not sufficient since this may result from inefficient mixing. An explicit reference to two layers must be made, for example 'two layers are formed, the top one being orange and the lower one being colourless'. Again, it should be noted that 'clear' is not the same as 'colourless', and 'cloudy' is not usually an acceptable alternative to 'precipitate', unless specifically stated as such in the Mark Scheme. Where colours are required in an answer it is important to note the Additional Guidance of the Mark Scheme where the statement 'any combination of these colours but no other colours should be mentioned' is often stated.

It is particularly important in Skill IV that the Centre carries out a trial run of the experiments in the Tasks before the Tasks are set to the candidates. This allows for any minor modifications of say solution concentrations that may be necessary when using the chemicals in the Centre in order that candidates' may achieve the correct observations. This is essential because credit should not be given for observations that are not in the Mark Schemes. It is not acceptable to say 'my candidates saw X and so did I so I am awarding the mark' even though the Mark Scheme expected an observation of Y.

In Skill V Tasks, candidates were sometimes asked to explain reactions in terms of acid/base, e.g. Task 1, part (c), or redox behaviour, e.g. Task 2, part (c), and Task 3, part (b) and (d)(ii). In these cases it is necessary for candidates to use terms associated with acids and bases or

oxidation and reduction in their answers rather than general comments about reactivity or displacement. In Task 3, part (b) in particular, the important point here is that there is an explanation of the observations. Given this an answer that does not include 'bromide' and 'bromine' should not score the mark. So answers such as 'chlorine removes electrons from bromide to form bromine' and 'chlorine changes the oxidation state of bromine from -1 to 0 ' would satisfy this requirement for explanation. Where structures of organic functional groups are required it is acceptable for candidates to include 'R' for alkyl groups or to use specific examples such as methyl or ethyl groups.

If, after using one of the Tasks, a Centre believes that an answer not included in the Mark Scheme should be marked as correct they should immediately check this with OCR using the e-mail address GCEScienceTasks@ocr.org.uk.

Clerical Errors

A number of Centres sent in marks that contained Clerical Errors. Sometimes this arose from transcription errors made in transferring candidate marks from their work to a spreadsheet. On other occasions it arose because a candidate had carried out more than one Task in the same Skill and the highest scoring Task was not used to calculate the total mark. However, it also arose where Centres had awarded a non-integer mark out of 6 for Skill I. The mark for Skill I should be the best fit whole number when judged against the marking descriptors so that when doubled to give a mark out of 12 it generates an even number. It is important that Centres check marks carefully in order to avoid such errors in the future.

Security of Tasks

Distribution of the practical Tasks is limited to those candidates who are currently undertaking that Task. Task sheets should be photocopied and issued to candidates at the start of the Task. They must be counted out and in; numbering the documents may help to keep track of them. In no circumstances should practical Task assessment materials be posted to a website where they can be accessed by the public.

All unused Tasks and candidates' scripts must be collected after the assessment and stored securely or destroyed.

All F333 Tasks, Mark Schemes and Instructions are live assessment materials for the life of the specification. These should be kept secure at all times even if they are not valid for assessment this year as they may be reissued in subsequent years. Tasks must only be made available to candidates for them to complete under controlled conditions and the completed Tasks must be submitted to the teacher at the end of the lesson. Mark Schemes and Instructions must be kept securely and not made available to candidates.

Availability of files on Interchange

Each year, Tasks (and Instructions for Teachers and Technicians) and Mark Schemes are available from 1 June. The same are removed by 15 May in the following year.

Clarifications/modifications to Tasks and Mark Schemes

From time to time OCR may need to publish clarification for a Task in light of centre queries. Centres should ensure that they check Interchange before using a Task for assessment to ensure that no modifications have been posted and that a check is made before final submission of marks to OCR by 15 May.

An e-mail alerts service is available. To be notified by e-mail when changes are made to GCE Chemistry B (Salters) pages Centres should e-mail GCEScienceTasks@ocr.org.uk including their Centre number, Centre name, a contact name and the subject line GCE Chemistry B (Salters). It is strongly recommended that all Centres register for this service.

Re-submitting Tasks in future years

Only OCR Tasks from Interchange clearly marked with the current assessment year, *i.e.* 1 June 2011 to 14 May 2012, can be used for practical assessment during that period.

However, if a candidate wishes to improve their mark they could re-submit their best 1 June 2010 to 14 May 2011 Task(s), along with a new (from the 1 June 2011 to 14 May 2012 selection on Interchange) Task from the other Skill(s). However, the marks confirmed by the Moderator when the Task was first submitted cannot be 'carried forward'. Teachers will be able to re-mark the Task in light of any comments made by the original Moderator and it will be re-moderated when it is re-submitted. Up to three Skills Tasks per student may be re-submitted (for example a student may have performed well in their Skills II, III and IV in June 2011 and re-submit them for moderation with a new Skill V Task in June 2012 – chosen from the Skill V Tasks available for assessment in the June 2012 session).

Where a candidate wishes to improve their mark, their Skill I mark can be re-submitted (their Competence Record Card will need to be re-submitted for moderation) or, where they have fulfilled the assessment criteria, their Skill I can be re-assessed and their new mark, along with a new Competence Record Card, submitted for moderation.

F334: Chemistry of Materials

The paper was of an appropriate level for candidates of all abilities to do themselves justice, whilst providing good discrimination; in virtually every question the full range of marks was awarded with candidates managing sensible answers to many of the questions and the very able candidates giving excellent answers. Overall the performance was pleasing and there was a noticeable improvement over the January examination in both the accuracy and depth of knowledge and examination technique. Clearly many had made a real effort to be prepared for the varied types of response required. However legibility of writing and presentation for some remains in decline and spelling continues to be weak on occasions. Poor communication skills mean that ideas are not always conveyed in a way which makes it possible to award marks. A lot of candidates continued their answers onto blank parts of the paper and additional pages and many did so without making it clear where they were going. Candidates should not continue answers below the lines of dots (unless it is the last question on a page). They should use additional pages, giving a clear reference to where the answer continues. On the additional page the part number of the question should be clearly indicated.

Calculations were much improved; students of all abilities gaining full marks, in some cases poor explanation prevented marks being awarded when the final answer was incorrect. The main problem remains in deciding an 'appropriate number of significant figures'. The writing of ionic equations was excellent but writing equations for organic reactions was a problem area for many.

Candidates at all levels showed good understanding in discussing the difference in boiling points of molecules, how enzymes are affected by damaged DNA, an understanding of infrared spectroscopy, the properties and reactions of hydroxyl groups, and in interpreting rate of reaction data.

Areas of difficulty were the flexibility of polymers, stereochemistry (optical and *E/Z* were often confused), understanding how catalysts work, interpreting electrode potential data, and in constructing the repeating unit for a polymer.

Many did not appreciate the rigor and accuracy required for constructing formulae and in describing mechanisms, often failing to secure marks due to carelessness rather than knowledge.

A careful analysis of most scripts reveals that the students' main problem, by far, is an inability to read the question fully. Highlighting key phrases and command words is to be encouraged as an aid to getting into the question and using all the information given. There is clearly time to do this since there was no evidence of time being a constraint in the examination.

Question 1

- a) Generally fine for all parts, but some were confused about the conditions for synthesising ethanal from ethanol.

Most common errors:

- (i) *ethanone, aldehyde*
- (ii) Often *refluxed* before *distilling* off the ethanal.
- (iii) Sometimes the C-O bond was thought to be relevant and the product identified in a non-specific manner as a carboxylic acid.
- (iv) Forgetting to *explain* that the ethanal was oxidised further.

- b) Parts (i), (iii) and (iv) were well answered.

Most common errors:

(iii) missing out *concentrated*.

In part (iv) most students achieved the mark for correct identification of ethanoic acid. Marks were mainly lost due to an incorrect formula for the ester or forgetting that there was a second product, water. Surprisingly, many students used molecular formula, often incorrectly, instead of structural formulae thus gaining no marks.

- c) The very able students answered this question succinctly with a logical progression of ideas and easily picked up full marks. However, many students went into great detail about the processes of translation and transcription or the roles of the different types of RNA and were showcasing their biology knowledge. Students really need to pay attention here to the relevant parts of the specification. Unfortunately this meant that some of the easy marks later on in the description were glossed over. The most common mark lost was the first one where students needed to recognise and state that enzymes were made up of a sequence of amino acids. This idea was almost never stated outright but tended to be implied or combined with the description of the second marking point.

Question 2

- a) Many students were able to discuss properties of polymers using ideas of bonding and structure and knowledge of the technical terms involved. However they often failed to make the appropriate connections regarding flexibility, room temperature and polymer structure.

Most common errors:

(i) Failure to relate the T_g data to room temperature.

(ii) Instead of starting with the idea of what makes polymers more flexible or brittle, i.e. the ability of chains to move over one another, which immediately focuses on the role of the methyl side-chain, they commenced either with the methyl group increasing intermolecular forces, or making packing less effective leading to increased flexibility.

(iii) Most gained this mark, of those that did not, most wanted to 'remove the methyl group'.

- b) Excellent answers to parts (i), (ii) and (v).

Most common errors:

(i) Many believed propanone could 'form hydrogen bonds because it has an oxygen'.

(ii) Cyanide rather than cyanide ion.

The mechanism in part (iii) caused more problems than expected. In a significant number of cases, the only mark gained was for the partial charges on the C=O. Many students clearly had not learned the mechanism (the only one in the F334 specification) as evidenced by difficulties with the actual structure and charge of the nucleophile itself (which led to problems with part (iv)), as well as the structure of the intermediate ion, and the need for a source of hydrogen ions. Many considered it to be a single step or even a three-step reaction despite the information given in the question.

(iv) The most common answers involved the idea of the triple bond between C and N being very strong and stable or the idea that carbon needs to make 4 bonds, and nitrogen only 3.

- c) Generally fine for parts (i) and (ii). Most students knew to reflux but the reagent mark was often lost carelessly by a failure to specify the concentration of the acid, missing out the water or using the alkali route instead.

- (iii) A large number of students were able to realise that only F exhibits *E/Z* isomerism but only a few were able to explain why. Many students had the right idea but failed to mention the different groups or said 'different groups *on each side* of the double bond' or 'different groups *across* the double bond'. Some drew appropriate diagrams to clarify their answers. Others gave reasons based on chirality or molecules being non-superimposable.

Question 3

- a) Some well constructed answers, though some students did not mention the alcohol group, or the colour descriptions for both compounds. A significant number did not get the reference to the 'R' group and went on to describe the chemistry of the OH in the carboxyl group. Some also gave a number of tests rather than just one, as asked for in the question.
- b) No real problems for the majority.
- c) Only the most able students gained marks here. Most ignored the 'amine side chains' information and went on to draw some sort of polyamide. Some managed to get the ester link name correct but drew the repeating unit with a variety of other groups including –OH and phenyl or having a COO– at one end.
- d) (i) A mark of 5 was a rarity here as both sides of the molecule were not acylated (a 50:50 choice it seemed). Many gained marks but the acylation posed the biggest challenge.
- (ii) Many students had the right idea and scored 1 mark, only a few scored both. A significant number did not understand what was happening here at all. Common errors involved hydrogen bond formation of water with tyramine and zwitterion formation by tyramine in alkali.

Question 4

- a) The variation in response suggests that a lot of students were guessing. Many answers given were for substances that were not and would not even be present in the bottle.
- b) (i) Some students were familiar with redox titration and were able to produce well constructed and coherent responses. Other students struggled to any gain marks at all, relying on their knowledge of an acid-base experiment. A surprising number of students did not mention a pipette at all, even fewer qualifying the pipette by type or volume to gain the mark. The most common omission was the acidification. Other major errors involved the reverse titration but still obtaining a pink colour at the end-point. Many students sought to use a variety of indicators (most of them producing a final pink coloration).

(ii) and (iii) Calculations involving moles:

Many students gained full marks here and those that did not made significant progress. Some students did not apply the stoichiometry correctly, often multiplying by 5/2. Many lost the final mark for significant figures although the rest of the calculation was carried out correctly to 3 significant figures but then they gave the final answer to 2 or sometimes 1 significant figure.

- c) Many students had the right idea about the change in oxidation state of the copper ions being an important concept in catalysis, and that lowering of the activation enthalpy increased the rate. Fewer students described the full process accurately or in enough detail and a number described heterogeneous catalysis instead, particularly those that referred to metals rather than metal ions.

In (ii) other homo-/hetero- prefixed words were common, including –olytic, –zygous, and –logous.

- d) (i) It was usually only the most able who could give a clear answer. Most did not write about concentrations.

The rest of the questions on rates were well tackled though some did not calculate at least 2 half-lives.

Question 5

- a) Most were aware of the singly occupied 4s orbital for Cu metal but a significant number failed to mention the 'ion' part of the definition of a transition metal.
- b) (i) Comparison of the E° values of copper and oxygen/water was done more effectively; not too many higher/lower, greater/smaller and electronegativity variations as in the past. The oxidising agent was rarely correctly identified for the second mark. In part (ii) common errors involved not comparing the E° values of iron and copper, and stating that copper(II) ions were reduced by the iron.
- c) A really good all round improvement with ionic equations though a number, having got the formulae and stoichiometry correct, failed to include any state symbols.
- d) Most gained a mark for a successful description but then did not 'explain' by stating that 'the barrier excluded both water and oxygen'.

F335: Chemistry by Design

General

As in previous years, this synoptic paper provided a challenge to candidates to which some responded very well. Others were able to perform well on certain questions only. There were few gaps and almost all candidates appeared to have had enough time to finish the paper.

Candidates used their knowledge and skills to respond well to questions on organic chemistry. Knowledge of functional groups and reagents and conditions were often good as was understanding of infrared and nmr spectroscopy and explanation of colour in dyes. Candidates showed improved ability to perform calculations, usually setting them out in such a way that 'error carried forward' could be applied when necessary. Candidates responded well to questions on equilibrium.

Some candidates did not have the knowledge and skills required to answer questions on bonding, particularly intermolecular bonding, to name inorganic compounds or to assign oxidation states confidently.

There were some very good responses to the long answer parts that showed both understanding of the concepts involved and an ability to express these in concise chemical language. Other answers were imprecise, using chemical terms incorrectly, or else they spent too long 'setting the scene' before hurriedly making some important points.

Candidates must be reminded that continuation answers should be written on additional pages (with clear reference both in the paper and at the start of the continued work), unless the question is at the bottom of a page when it is permissible to continue to just above the bar code. Over-writing and partial 'rubbing out' should be avoided – it is better to cross out an answer and re-write it correctly.

Individual Questions

Q1(a) Many candidates made a good start here, showing understanding of the reagents and conditions necessary for coupling reactions.

Q1(b) There were some good answers to part (i) that quickly identified '2 amine groups are between 1 and 3; orange is between brown and yellow'. Other answers were muddled and less concisely expressed. Part (ii) was often well done. Only occasionally were electrons described as emitting colour as they fell back down energy levels. The best answers made it clear that change in the delocalisation of the different dyes resulted in difference either in the energy gap or the frequency absorbed. They also quoted $\Delta E = hv$, rather than just $E = hv$ disconnected from any energy change.

Q1(c) Good answers related stability to delocalisation and said that this was retained in substitution but lost in addition. Other answers usually mentioned delocalisation, without specifically referring to one or more of stability, addition or substitution.

Q2(a) In part (i) some good answers recognised that sulfur had been both oxidised and reduced. These candidates were confident of the oxidation states in all the substances, especially CuS. Other answers gave sulfur for either oxidised or reduced, but another element (often copper reduced) in the other category. In part (ii), good candidates were able to write one of the two acceptable equations, others added extra reagents or invented unlikely products.

Q2(b) started well with most answers to part (i) correct. There were a few cases of subscript numbers that were not accepted. Again in part (ii), many candidates were able to produce perfect answers. Others forgot the lone pairs on the fluorine atoms or did not realise that sulfur could 'expand its octet'. In part (iii) there were many accurate three-dimensional diagrams. Candidates are advised to draw an 'accepted' diagram, for example the one in Chemical Ideas. Almost all candidates understood what was meant by bond angle and many correctly described it as 90° .

Q2(c) began well with a vast majority of correct answers in part (i) to an appropriate number of significant figures. In part (ii) many gave an acceptable answer. 'Dilithium sulfide' did not score nor did 'lithium sulfide(II)'. There were a good number of correct answers to part (iii). 'Network' contradicted 'covalent' for sulfur hexafluoride in a few cases and answers in terms of intermolecular bonding were not accepted.

Q2(d) was usually well done, showing a good understanding of the relationship of intermolecular bonding to melting point. Candidates must realise the need to take trouble in such a 'Quality of written communication' question to spell words like 'instantaneous' correctly and to ensure they are clearly legible.

Q2(e) was usually well done, omission of the positive sign in part (ii) being the major error. Fewer candidates failed to convert the ΔH to joules than in previous sessions.

Q2(f) Only a few correct answers were seen to part (i). In part (ii) good answers realised that the reaction would be spontaneous but that it had a high activation enthalpy. This second point was made only by a handful of the best candidates. Answers confusing a fuse with an electrical fuse and use of a fuse for safety reasons were often seen.

Q3(a) was answered correctly by a majority. Many showed lack of understanding of 'molecular formula' by giving answers like $C_6H_5CH_2COOH$.

Q3(b) A few correct answers were given. Many omitted carbon dioxide as a product or took oxygen atoms from the acid formula when forming the salt.

Q3(c) was the first time that 'retrosynthesis' had been examined and candidates responded well. In part (i) there were many correct curly arrows. Other candidates must appreciate that it is important to consider exactly where such arrows should start and finish. In part (ii) some candidates understood that synthons were theoretical species that often did not exist and in part (iii) there were many correct answers. Part (iv) was a matter of correctly interpreting the Data Sheet and the vast majority of candidates achieved this. Answers to part (v) were usually good, showing a sound understanding of the effect of temperature on equilibrium position.

Q3(d) had good responses to parts (i) and (ii) and particularly good answers to part (iii), showing an excellent understanding of the basics of infrared spectroscopy. Answers to part (iv) were usually good. Some candidates were not careful enough in drawing round the relevant part of the molecule, with lines going through atoms rather than bonds. Some good answers to part (e) were to be contrasted by others that left a hydrogen off the cation, or that involved the chlorine atoms on the acid in the reaction. Most realised in part (ii) that the salt would be soluble in water.

Q3(f) was a 'how science works' question that performed well. Many candidates were able to give at least one acceptable answer.

Q4(a) Good answers contrasted with those that left off the 'di' and the minority that wrote 'ethene'.

Q4(b) required candidates to have a good understanding of 'electronegativity' and 'dipole' and to be able to communicate clearly in chemical language. There were some very good answers that scored full marks in relatively few lines. Answers to the first bullet sometimes did not 'describe and explain'. Some answers to the second two bullets were sometimes side-tracked into talking about symmetry rather than considering what dipoles were present (and why) and whether they cancelled in the molecules.

Q4(c) was well done.

Q4(d) tested candidates' powers of expression to the limit. The best answers were able to make it clear that the intermolecular bonds were the same between the *same* molecules of the halogenoalkanes and between *different* molecules, and to name these as either permanent dipole-permanent dipole or instantaneous dipole-instantaneous dipole. They then went on to state that water *itself* had hydrogen bonds but that hydrogen bonds could not form between water and a *halogenoalkane molecule*. Less effective answers failed to make some of the italicised points clearly.

Q4(e) part (i) was often answered well with clearly drawn curly arrows which started and finished accurately. In part (ii) many candidates made both the 'positive species' point and the 'receives electrons to form a bond' point. In other answers, more scored the first point than the second. Part (iii) had a few candidates making it clear that the chloride ion could not act as an electrophile but that it could attack the carbocation once formed. Other answers implied that sodium still had a hold over chlorine in the solution or that it was a matter of chlorine and bromine replacing each other.

Q4(f) was correct for many candidates, who avoided the route using cyanide which would have given butanedioic acid.

Q4(g) Almost all candidates realised that it was the 1,2-dibromo structure and that there was lots of evidence for this. By following the bullet points carefully they could then have scored the marking points. Only a few were put off by the fact that the two bromine atoms on the same carbon change the chemical shifts from those shown in the Data Sheet. Some answers did not make it clear that it was the hydrogens *on an adjacent carbon atom* that caused the splitting. 'Adjacent environment' would not do.

Q5(a) part (i) was answered correctly by many. Other answers showed the lack of confidence in naming inorganic compounds that has been mentioned elsewhere. In part (ii), a few candidates gave the correct answer.

Q5(b) part (i) was correct in almost every case. A few careless errors and plus signs were seen. Part (ii) was also good with just the occasional candidate failing to take the square root.

Q5(c) part (i) showed that candidates could explain the meaning of 'buffer solution' and relate it to enzymes in cells. Good answers to part (ii) included the point that the 'salt' was present in large concentrations. This point was seen in a good proportion of answers. Part (iii) was usually answered correctly.

Q5(d) had some good answers where candidates had carefully substituted values into the K_a expression. Other answers multiplied 0.1 by 120, not realising that the data was for two different substances.

Q5(e) part (i) was done well by candidates who explained their calculations. Full credit could not be obtained from a jumble of figures from which '7.5' emerged at the end, without some indication of which substance was being discussed. In part (ii) just a few of the best candidates realised that the acid ionised as H^+ ions reacted with the sodium hydroxide.

Q5(f) was often well done. A good number of candidates understood that the enthalpy change of hydration was a sum for the ions. Most also understood that the enthalpy of solution was exothermic.

F336: Chemistry Individual Investigation

General Comments

In most centres candidates undertook appropriate investigations that allowed them to demonstrate their chemical skills and knowledge. In some cases the work was of exceptional quality that went well beyond that which might normally be expected of A2 Level candidates. In a few cases candidates needed to spend more time on their investigations to allow their ideas to develop and to collect sufficient results.

A greater range than usual of investigation topics was chosen by candidates. Chemical kinetics projects were again very popular but analysis, organic synthesis and less common topics such as the Freundlich Isotherm, biofuel production, partition coefficients of organic acids and double salts and hydrates were also noted.

A few candidates needed to choose more demanding topics to investigate. Investigations such as acid and thiosulfate and simple electrochemical cells do not allow candidates to develop their skills and understanding sufficiently. Other candidates chose experimental methods that were too biological in nature and so lacked the essential chemical component required by this assessment component.

It is expected that centres will annotate candidates work or provide detail about why marks were awarded in each Skill area on the candidate cover sheet. In some cases very precise comments were provided that proved very helpful to moderators whilst in other cases more comments were needed that went beyond a re-statement of marking criteria and explained exactly why less than full marks had been given. It is particularly helpful if candidates' work is annotated to pick out the good or weak practice where it is identified.

Written evidence arising from direct teacher observation of candidates at work in the laboratory should be sent to the moderator to support the mark awarded in Skill G. This often takes the form of an aide-memoire in which the teacher adds comments several times during the course of investigations. Centres should ensure that they think ahead about how they are going to collect this evidence and should send it to the moderator with candidates' work.

Most candidates presented their investigation reports well with almost all work word processed. Most candidates seemed to benefit by dividing their report into distinct sections to cover theory, method, results, analysis and evaluation. Such a practice is highly recommended.

OCR provides INSET days in the Autumn Term that cover all aspects of the Individual Investigation. These courses provide teachers with guidance and help about planning, carrying out and marking F336 coursework.

Skill Area A

This section of the investigation was generally carried out well by candidates. Some candidates need to ensure that they only include theory that is relevant and related to their own investigation. This is particularly important in enzyme related projects where the inclusion of material of a more biological nature should be avoided.

In investigations into chemical kinetics, theory about methods in general should be developed to include detail related to the particular reaction under investigation such as the use of $1/t$ to measure initial rate of reaction or the use of an Arrhenius plot to determine the enthalpy change of the reaction.

Skill Area B

There were many examples of good practice in this Skill area where candidates provided sufficient detail about experimental methods so that another student could have used the account as a set of instructions to repeat the experiments. In a few cases candidates could have been more ambitious in the amount and range of experiments that they carried out which would have allowed them to develop their use of chemical techniques and related chemical ideas more fully. In a few cases candidates needed to consider more carefully whether the experiments that they chose would help them achieve their stated aim, particularly where they needed to ensure that the experiments would lead to precise quantitative analytical data.

Skill Area C

The marks awarded in this section were sometimes a little higher than was merited. Candidates need to take care to link their risk assessment with the concentration of solution used in the investigation, to make explicit the content of web sites cited as references and to link references to relevant parts of the plan. Spelling and grammar used in the plan were usually very good but sometimes the account needed greater clarity.

Skill Area D

Very few issues arose in this Skill area as most candidates recorded sufficient good quality data and recorded the results in a clear and helpful format. Some candidates need to take greater care in recording the results of titrations.

Skill Area E

In this section candidates are expected to manipulate the data they have recorded, often by drawing graphs or carrying out calculations, and then to use appropriate chemical ideas to draw conclusions from the manipulated data. Some candidates need to develop the second of these aspects to provide a clear summary and explanation of what they have achieved during their project. Some candidates also need to take greater care with the presentation of their graphs so that they can be easily understood, provide accurate information and are clearly linked to a specific set of results.

Skill Area F

When evaluating percentage errors it is expected that candidates will use the correct error for each particular piece of equipment, will calculate the percentage error for all types of measurement and will show their calculations clearly.

Comments on the limitations of experimental procedure can be quite brief and limited. Some candidates would benefit by developing this aspect of their report to ensure that key points relating to all of their experiments are included. Candidates seem to achieve this most easily by grouping all of their comments together rather than spreading them out in different parts of their report.

Skill Area G

It is expected that there will be a range of marks for this Skill area submitted by centres to match the range of performance that is usually seen in marks for Skill area D. Many centres need to check that the range of marks for their candidates in this Skill does cover an appropriate range.

Skill Area H

The marks awarded in this section were not always appropriate for the investigation undertaken. As an example, a kinetics investigation in which the concentrations of reactants are changed in order to determine the orders of reaction and the temperature changed in order to determine the activation enthalpy via an Arrhenius plot should be awarded a mark of 3 out of 5.

One mark is available in this Skill area to reward candidates who are particularly innovative or show a high level of problem solving. To be awarded this mark it is expected that candidates will show real flair beyond the normal expectation of candidates.

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