

**GCE**

**Chemistry B (Salters)**

Advanced GCE **A2 H435**

Advanced Subsidiary GCE **AS H035**

**OCR Report to Centres June 2016**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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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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**Advanced GCE Chemistry B (Salters) (H435)**

**Advanced Subsidiary GCE Chemistry B (Salters) (H035)**

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## F331 Chemistry for Life

### General Comments:

The level of response was higher than usual. Generally candidates performed well, demonstrating sound knowledge of the specification, with many seeming well practised in questions typical of past papers.

Calculations were generally well done although significant figures are still a problem.

Candidates failed to score on some questions because their answers were not specific enough, not in enough detail or were just too generic. A small, but significant, number of candidates lost marks because they had not read the question carefully enough.

There were very few 'no responses' and most answers were full with an attempt to give a clear answer.

Some candidates were given additional objects to write on without using the extra lined space at the back of the exam paper. This can slow down the marking process and Centres should encourage the use of the extra lined space before using additional sheets.

### Comments on Individual Questions:

#### Question 1

This was a straightforward question to settle candidates and was generally successful in its aim.

**1(a)(i),(ii),(iii)** The three parts were generally well- answered; The most common mistake in a(ii) being the naming butan-1-ol as simply butanol.

**1(b)** Very straightforward.

**1(c)(i)** More discriminating, but a majority of candidates were successful.

*Numerical answer: 835g*

**1(c)(ii)** The most common error here was to get the fraction the wrong way around, i.e. dividing the molar mass of the butanol by 835.

*Numerical answer: 11g*

**1(c)(iii)** Very straightforward.

**1(c)(iv)** This calculation was one of the most discriminating questions on the paper, with the correct use of significant figures causing problems for some candidates.

*Numerical answer:  $3.62 \times 10^4$  (36,200)  $\text{kJ kg}^{-1}$*

**1(d)** Not well-answered, with many candidates giving a stock answer of 'carbon neutral' despite the question being phrased to point towards renewability of the source.

#### Question 2

This question, overall, was more difficult than Question 1 and more discriminating.

**2(a)(i)** This part question was generally well-answered, although a small minority still put the mass and proton numbers on the right of the element/alpha symbol.

**2(a)(ii)** This question tended to yield both marks, or zero. The formation of magnesium oxide, a relatively common answer, is really only possible if the reacting water is in the form of steam.

**2(a)(iii)** Candidates had little difficulty with this question on metallic bonding.

**2(b)(i)** A longer answer question, that looked at ways of determining the thermal stability of Group 2 carbonates. Some candidates took the order in the table as being the group order and answered accordingly, inevitably losing marks. Other candidates failed to calculate the loss in mass and therefore failed to realise that the loss in mass, and hence the number of moles decomposed, decreased down the group.

**2(b)(ii)** This one mark question was not well-answered and only the better candidates linked the toxic nature of  $\text{NO}_2$  with the need to do the decomposition in a fume cupboard (gas masks did not gain marks).

**2(c)(i)** A significant number of candidates did not link the idea of Hess' Law to the enthalpy cycle given (as asked for in the stem of the question); others failed to realise that it was the initial and final conditions that needed to be the same.

**2(c)(ii),(iii)** Both straightforward questions well answered.

**2(c)(iv)** Unfortunately some candidates lost this mark by not putting the sign of the enthalpy change.

**2(c)(v)** A small but significant minority of students answered a previous years question here by putting 'incomplete combustion'.

### Question 3

This question, overall, proved the trickiest and most discriminating.

**3(a)(i)** A surprising number of candidates thought sulfur was soluble in water and another common error was to talk of conduction of potassium nitrate in solution or when molten, which is not the property being described in the table.

**3(a)(ii)** Candidates found this question difficult because few linked the electronic structure with the number of outer shell electrons needed to start filling the p sub shell.

**3(b)** The more able candidates tended to score this mark. The most common error was to juxtapose Bohr and Schrodinger.

**3(c)** This calculation was relatively discriminating, with the more able candidates realising the second step required adding together the number moles of each component.

*Numerical answer: 34%*

**3(d)(i)** Many candidates decided that a potassium compound would be covalent.

**3(d)(ii)** The main reason candidates lost marks on this question was they failed to compare the nature of the reactant and product 'species' and how any differences related to entropy.

**3(e)(i)** Errors or omissions in answers to this emission spectra question included; suggesting that electrons falling back levels, always went to the ground state, and, not linking the labelled electron movements to lines in the spectra.

**3(e)(ii)** A high success rate was seen on this question

**3(e)(iii)** Unfortunately a significant minority of candidates answered this question just by re-phrasing the stem; failing to connect unique energy gaps between electronic energy levels, and hence a unique positioning of lines, to different elements.

**3(e)(iv)** Some candidates dropped unnecessary marks here by not comparing the differences between absorption and emission spectra.

**3(e)(v)** This proved the most difficult question on the paper. Soot or man-made being common answers instead of particulate.

#### **Question 4**

The final question proved fairly straightforward overall for the well-prepared candidate.

**4(a)(i)** Generally well-answered but some candidates lost a mark by not explaining it was the number electron groups around the central, silicon, atom which were key.

**4(a)(ii)** A significant minority of students lost this mark because they used solid lines opposite each other, rather than adjacent to each other, in their structures.

**4(b)(i)** Candidates had learned the characteristics of heterogeneous catalysis to good effect.

**4(c)(i)** Correctly answered by most candidates.

**4(c)(ii)** Most candidates managed one of the two allowable isomeric structures.

**4(c)(iii)** The first mark in this question was for the idea that the holes/pores in zeolite have similar proportions to the molecules passing through/over the zeolite. Candidates scoring this mark usually used the term molecular sieve.

The second mark was sometimes lost because candidates failed to relate the structure of isomers F and G to their answer, despite the stem of the question asking for such a connection to be made.

**4(c)(iv)** The majority of candidates gave the correct answer of hydrogen.

## F332 Chemistry of Natural Resources

### General Comments:

This legacy paper was accessible to the majority of candidates, with few very high or very low marks which may not have been surprising as it was a 're-sit' paper for the majority of the candidates. There were few 'non responses' to questions and where they were, it indicated a lack of knowledge rather than insufficient time to complete the paper.

Centres should remind their candidates to ensure that any draft work, especially structures, mechanisms and 'dot - cross' diagrams, should be thoroughly erased or deleted as the marking of the scanned images was often difficult because this had not been done.

Calculations were generally handled well but students need to provide more explanation of the steps they are taking in the calculation to enable 'error carried forward' marks to be awarded.

Questions 1, 2 and 3 generally scored a higher proportion of the marks available than questions 4 and 5, which contained the longer-response questions which were often not answered well. Here, more care is needed by candidates to ensure they focus their answer with more precision on the question asked.

### Comments on Individual Questions:

#### Question 1

**1(a)(i)** Most candidates scored at least one mark here. Referring to 'molecules' was a surprisingly common error and many candidates' answers were more appropriate to Q.1 (a) (ii).

**1(a)(ii)** Many candidates did not score for this question. Common mistakes were writing only about the features of graphite and some answers were not specific enough, for example omitting the word 'every' when describing the bonding between carbon atoms.

**1(b)** The majority of candidates scored only one mark here, either because they had not completed the calculation or more commonly, having successfully completed the calculation (187) they then failed to round it to the 2 significant figures asked for.

**1(c)(i)** Answered well; although some candidates just referred to 'pressure' omitting 'high'.

**1(c)(ii)** The majority of candidates scored at least one mark although many had not read the question carefully enough and gave answers in terms of *putting less* carbon dioxide into the atmosphere rather than *removing* it.

**1(c)(iii)** The polluting effect of carbon monoxide was answered very well. For carbon dioxide, many answers just stated that it was a greenhouse gas, without describing the *effect*.

**1(d)** Answered very well by most candidates; showing a good understanding of position of equilibrium and how one equilibrium reaction links to another.

**1(e)(i)** Answered well by most students. Some evidence of 'pre-prepared' answers regarding infra-red which did not always fully address the question. For example many discussed the fingerprint region in broad terms and had not appreciated the 'interaction' part of the question.

**1(e)(ii)** This calculation was answered well, with the majority of students obtaining maximum marks.

## Question 2

**2(a)** Most candidates scored only one mark, for referring to the energy needed to break the inter molecular bonds/forces. The majority of students had not appreciated the symmetry of tetrafluoroethene and that it did not therefore, have permanent dipole - permanent dipole interactions. Many also thought it contained hydrogen bonds because it contained fluorine.

**2(b)** Answered reasonably well; although some candidates used an 'n' after the bracket around their structure which is incorrect, as this would show a repeating unit. Others lost marks due to careless mistakes, for example having an H instead of an F when the remainder of the structure was correct. Very few mistakes seen on the omission of bonds at each end of the structure.

**2(c)** Answered well.

**2(d)** Answered well.

**2(e)(i)** Answered well.

**2(e)(ii)** Most candidates scored at least one mark. For the second mark they needed to refer to a *bond* being formed from a *pair* of electrons and either one of these was frequently missing from the answer.

**2(e)(iii)** Candidates found this question difficult and did not seem to have understood the electrophilic addition mechanism. Many answers were in the context of chlorine/chloride displacing the bromine. Terminology was often poor; for example confusing electrophile and nucleophile or incorrectly referring to *chlorine* or *bromine* ions.

**2(f)(i)** Most scored for 'water' but many incorrectly stated sodium hydroxide as the nucleophile.

**2(f)(ii)** Answered well.

**2(f)(iii)** Answered well.

**2(f)(iv)** The majority of candidates scored at least one mark. Centres need to remind candidates that they must refer to *particles* when describing kinetic energy and to energy of *collisions* when linking to activation energy.

**2(g)(i)** Answered extremely well. Very few instances of an additional bond line drawn to the left of the described bond.

**2(g)(ii)** Answered very well.

**2(h)** Generally answered well but many responses to the 'aldehyde' answer had the formula as COH.

## Question 3

**3(a)** Answered well.

**3(b)** Generally answered well. Some mistakes with balancing (omitting the 2 for HCl) and some split the NaOH into aqueous ions which was not in context of the supplied left hand side of the equation.

**3(c)(i)** Some students understood the concept of the magnesium and calcium ions either being attracted to the membrane, or passing through it, but hadn't made the link to the effect of this happening.

**3(c)(ii)** Answered well.

**3(c)(iii)** Candidate's responses generally showed that the concepts were understood, but the terminology was often not sufficiently precise to enable marks to be awarded. A common example would be correctly referring to more/less shielding, but not stating that it was the *outer* electrons which were affected.

**3(d)(i)** This question produced a wide range of marks. Arrows were generally well drawn (very few single headed arrows) and although they were not credited for this question, partial charges were also generally accurate. Many missed the lone pair on the chlorine from the H-Cl and many had the production of a chloride ion from the H-Cl.

**3(d)(ii)** Answered very well.

**3(e)(i)** Answered extremely well, although many small spelling errors which were allowed.

**3(e)(ii)** Answered well, although some balancing errors and incorrect formula of barium chloride.

**3(e)(iii)** Most candidates made good progress with this calculation and achieved full marks. However, Centres need to remind candidates to explain the *steps* in their calculations, so that 'error carried forward' marks can be awarded if a mistake is made.

#### **Question 4**

**4(a)** Answered well.

**4(b)(i)** Not answered well which was surprising, as candidates would have covered this again in Agriculture and Industry (Nitrogen Cycle).

**4(b)(ii)** Not well answered, as candidates had neither read the question properly nor used a human *activity* as their example.

**4(b)(iii)** Answered well.

**4(c)** Candidates found this difficult, often either scoring zero or 2 marks. Incorrect configurations included nitrogen with 6 or 10 electrons in outer shell, or diagrams of NO<sub>2</sub>.

**4(d)** Most candidates made a correct conversion. The second mark was frequently lost due to incorrect rounding of their answer.

**4(e)** This question produced a wide range of marks but was well answered. The structures were in general correctly drawn and identified with E or Z. Incorporating the E and Z into the name was frequently not attempted, perhaps because the term 'systematic name' was not noticed or understood in the question. Some labelled their structures 'cis' and 'trans', which although correct is not systematic. But-2-ene was often incorrectly named butan-2-ene.

**4(f)** This question was poorly answered, with less than half of the candidates gaining marks. The most common error was using Carbon Dioxide instead of Argon

**4(g)(i)** Poorly answered. Not many candidates appreciated that the question was about scientific method/rigour.

**4(g)(ii)** Answered well.

**4(h)** This question produced a wide range of marks with most students scoring at least some of the marks for how hydrogen bonds form. Very few students used a diagram to illustrate this and lost the opportunity to obtain the 'to another' molecule part of marking point 3.

Common misconceptions were that there is air in the spaces between molecules in ice, or ice is a covalently bonded (giant) lattice structure. Candidates often incorrectly used polymer chemistry terminology to describe the proximity of the molecules, e.g. 'packed closely together'. The QWC mark proved difficult to score.

### Question 5

**5(a)** Answered well.

**5(b)(i)** Answered well.

**5(b)(ii)** Candidates found this question difficult. Many scored the easier mark for the left hand side of the equation but found the right hand side harder to identify and accurately represent the structures.

**5(c)(i)** Only half of the candidates correctly identified a termination reaction.

**5(c)(ii)** Many candidates clearly understood the energy changes associated with bond breaking/bond forming but had not realised that they needed to state that *only* bond forming was involved. They would have found this difficult if they had not correctly identified a termination reaction in Q.5. (c) (i).

**5(c)(iii)** Very few candidates were able to determine the propagation step and produce the correct equation.

**5(d)** Answered well.

**5(e)(i)** Candidates frequently did not state that it was a *particle* or that the 2 unpaired electrons were on *different* atoms.

**5(e)(ii)** Many students failed to identify that it was the C-Cl and C-I bonds that were breaking so did not gain marks. The concept of linking the energy of the bond and frequency was poorly understood and explained.

**5(f)** This question produced a wide range of marks with most students scoring half of the available marks. Some answers were not given in sufficient detail, even though they were directly from the text of the article. The QWC question which linked the idea of two unpaired electrons resulting in greater reactivity was not often scored.

## F333 Chemistry in Practice

### General Comments:

#### Organisation of work

Given that 2016 was the legacy year (effectively the eighth year) of this assessment component, Centres are familiar with its' general demands. However, if any Centres do need to submit any work for this Unit next year it is still important that teachers familiarise themselves with the **Practical Skills Handbook**. This should help to avoid some of the mistakes that are still seen during the moderation process.

Candidates' work was usually well organised and labelled. However, it is disappointing that even in this legacy year a very small number of Centres do submit all work, leaving the moderator to sort it out, or work without candidate numbers, both of which inevitably slows up the process of moderation. 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) and Centre Authentication Form (CCS160).

Centres should group the candidate's four best Tasks together loosely, e.g. with a treasury tag, and **not** put the work in plastic document wallets, when submitting work to the moderator. These plastic wallets are still seen far too often. Attaching the Coursework Cover Sheet to the front of the candidates' four Tasks also greatly assists the process of moderation. Centres should 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. Where this does not happen the process of moderation is delayed.

Centres generally had re-submitted tasks from 2015 with usually 1 new task having been completed, quite often a new version of skill IV particularly Task 2 the iron chemistry and students appeared to have scored well on this Task.

#### 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.

#### Clerical Errors

Very few Clerical Errors were seen. Where they did occur this arose from transcription errors made in transferring candidate marks from their work to a spreadsheet.

#### 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) are available from 1 June while the Mark Schemes are available from 1 December. The same are removed by 15 May in the following year. However, except in rare cases 2016 was the last year when these Tasks will be available for legacy candidates.

### **Clarifications/modifications to Tasks and Mark Schemes**

For any Tasks that are still available after this year, 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](mailto: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 2016 to 14 May 2017, 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 2015 to 14 May 2016 Task(s), along with a new (from the 1 June 2016 to 14 May 2017 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 2016 and re-submit them for moderation with a new Skill V Task in June 2017 – chosen from the Skill V Tasks available for assessment in the June 2017 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.

## Comments on Individual Questions:

### 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. A small number of 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. Such a situation then causes a delay in the process of moderation.

The marks awarded to candidates by most Centres for Skill I generally 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. Rarely is the mark for Skill I less than that scored in Skill II and Skill IV.

However, this year there were instances where a Centre submitted no Skill I evidence until contacted by the moderator. Not surprisingly many Skill I marks were re-submitted from 2015. Most had re-allocated marks correctly by re-assessment and the appropriate documentation was included in the sample. However, some Centres had 'endorsed' its Skill I marks using candidates' performance from F336 and there was an example where a Centre had used Skill II and IV marks to inform the mark given for Skill I. Neither of these cases should happen.

### Skills II-V

Whilst the marks awarded to candidates by a small number of centres for Skills II to V represented a very accurate application of mark schemes to candidates' work, the majority of Centres showed varying degrees of deviation in their marking from the published Mark Schemes. Also there were a small, but not insignificant number of Centres where the marking was deemed to represent an inappropriate application of the Mark Schemes.

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 had not been checked, for example of initial from final titres in titrations, or initial from final temperatures in thermochemical experiments. 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 (titrations), Parts (d)-(h), and Task 3 (thermochemical), Parts (d)-(g). The Additional Guidance for Task 3, Part (h) also requires very careful reading. Furthermore, 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.

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.

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 yellow precipitate is formed for 1 mark (Task 1, Part (f) (i)), then both colour and an indication of solid will be expected. So, 'yellow mixture with precipitate' does not score this mark. Similarly, if the Mark Scheme requires both a dissolving of a precipitate (on warming) and a reappearing (on cooling), with the second mark depending upon the first, then 'solid after cooling' does not score if the dissolving of the solid has not first been described (Task 1, Part (f)(ii)).

Again if the Mark Scheme requires candidates to identify the formation of two layers in a test tube (Task 3, Part (a)), then both marks cannot be scored if two layers are not mentioned even if the colours of the two layers are correctly stated.

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. However, the word 'transparent' is acceptable in place of 'clear'.

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.

As has been stated before, it remains 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 such cases the Centre is required to contact OCR using the e-mail address [OCR.GCEScienceTasks@ocr.org.uk](mailto:OCR.GCEScienceTasks@ocr.org.uk) giving details about the observations made by the teacher. If OCR endorses this change then the answers of all of the candidate (or the relevant group of candidates, if appropriate) may be marked according to the Centre observations only. A copy of the relevant communications must then be included with the sample of work for the moderator.

In **Skill V Tasks**, that consider organic reactions, where structures of organic functional groups are required, the functional group must be attached in an unambiguous way, that is to say it is the oxygen atom of the hydroxyl group that is attached to the carbon atom.

Indeed a general point is that as the detail in the Mark Schemes has increased with time, especially the content of the Additional Guidance, Centres must read the answers of candidates in full and not simply award marks for key words if either the full meaning is not conveyed or contradictory statements are made.

Where equations are required, formulae must be written in the conventional way. Also when separate marks are awarded for the equation and the state symbols, the mark for the state symbols can be awarded, if the states are correct, even if the equation itself is incorrect. However, careful checking is essential.

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 [OCR.GCEScienceTasks@ocr.org.uk](mailto:OCR.GCEScienceTasks@ocr.org.uk).

## F334 Chemistry of Materials

### General Comments:

There were few really poor scripts and it was pleasing to see that candidates of all abilities were able to show a good understanding of some theory as well as an appreciation of the applications and implications of chemistry to everyday life. One area that was decidedly much better this year was the understanding of IR and Mass spectroscopy; use of data and logical interpretation was generally excellent. Understanding polymer properties and the ability to use correct language in a logical manner was also much improved.

Some of the calculations were tackled poorly, except by the mathematically inclined candidates; perhaps the unusual context in Q.3(ii) caused some initial confusion and failure to think the problem through logically. Certainly it led to good differentiation. The calculation involving electrode potential data also caused more than a few problems.

Responses to the extended writing questions were generally well organised and showed a good understanding of the theory involved. Some wrote at length about allied ideas without addressing the question asked. Spelling and grammar is increasingly variable and often inventive.

Writing formulae of all types remains a problem, too many are carelessly written with H atoms often missing and bonds joining groups via an inappropriate atom. Checking that equations are balanced, both by mass and charge, was often left undone, prevalent across the whole ability range.

Rubbing out pencil structural formulae is still on the increase, this proved most difficult to mark, as the scanning, black and white, showed up both attempts and often they were difficult to distinguish. Candidates should be encouraged to draw a line through their first attempt and then use the additional pages at the end of the question paper, only using an extra booklet if these have been filled. Few candidates provide clues that their answer is continued on additional sheets or added booklet.

The paper seemed of appropriate length, it was rare for a candidate to not get to the final question, Q.5(c). There were fewer blank answer spaces, even with the more difficult questions, with most attempting some sort of response even when it was clear they had misread the question. There were several questions demanding careful reading of the stem and command words for a meaningful response to be made. It was clear that 'describe' and 'explain' were often interchanged resulting in poor scores. Thankfully this session 'name' was rarely interpreted as 'give the formula'.

### Comments on Individual Questions:

#### Question 1

**1(a)** This gentle introduction to the paper on protein and structure was very well answered by most candidates.

**1(b)** Most were able to follow on to discuss successfully the function of the 'active site' in an enzyme. These first two parts clearly gave candidates confidence to tackle the challenges ahead.

**1(c)** Most could hydrolyse a secondary amide successfully although some unfortunately decided that ions, of varying types, would be produced. Many also hydrolysed both amide linkages, whilst others made simple errors in drawing the correct structures, notably missing the H off the remaining amide linkage.

**1(d)** Some splendid answers, but generally disappointing; instead of focusing on comparing bromate and trypsin, many wrote in generic terms about reaction rate and cost of catalysts, for which they had no data.

**1(e)(i)** Some excellent succinct answers showing clear understanding and using all the terms correctly and explaining in relatively few words, fitting the response easily into the space provided. The most frequently lost mark was the first for failing to explain with appropriate detail how the graph supported their conclusion that the initial rate was a first order process with respect to the substrate. The idea of rate determining step was often not referred to at all.

**1(e)(ii)** Instead of 'describing the graph' as requested most tried to explain what happened to the rate of reaction, thus not many gained the first mark. Often 'denaturing' was used without any explanation in what way the 'natural' structure of the enzyme was altered.

## Question 2

**2(a)(i)** A definite improvement in comparing electrode potential data and in using the technical language correctly. However, some candidates had the chemistry correct but inexplicably put the solutions in the wrong tanks.

**2(a)(ii)** Excellent, only a few tried to adjust the stoichiometry of the equation resulting in unbalanced charges.

**2(a)(iii)** Most realised that rusting was a major problem, but far fewer thought about the effect of the solutions. Coatings varied, the commonest was the use of zinc followed by oil and grease!

**2(a)(iv)** How an electrochemical cell works is clearly not understood. Many had 'electrons flowing through solutions' and often conned 'salt bridge' by qualifying it in the same way. Prevention of mixing was also a common response.

**2(a)(v)** Despite the expense, platinum was by far the commonest answer.

**2(b)** This proved trickier and many got the wrong or no sign whilst 1.80V was fairly common. (-0.26V).

**2(c)** Although there were many excellently constructed answers, many confused the precipitate with rust. Often iron(II) hydroxide was initially formed as a green precipitate before being oxidised to iron(III) hydroxide or hydrated iron(III) oxide. Not surprisingly only the best candidates could correctly construct an equation for the oxidation of  $\text{Fe}^{2+}$  ions.

## Question 3

**3(a)** Most candidates correctly calculated the moles of  $\text{C}_6\text{H}_{10}$  but many of these were unable to convert this into the bromine number. (390)

**3(b)(i)** Generally well attempted by a variety of methods but many not using words to explain their calculation and subsequent understanding.

**3(b)(ii)** Only the most able scored full marks with their working often clearly presented. The majority usually got off on the wrong foot, calculating moles of the  $\text{C}_6\text{H}_{10}$  and thereafter losing their way. Some ignored the request for a whole number. (7).

**3(c)(i)** Well understood, although some asymmetric carbons were still in evidence.

**3(c)(ii)** Some very good attempts but only the best gained full marks. Frequently E/Z and Z/E isomers were both included. Labelling was often good though some just focused on drawing structural formulae for molecules with one C=C bond and hence only one label.

**3(d)** Many began by unnecessarily filling up the answer space by explaining the phrase ‘heterogeneous catalyst’. Further discussion either involved a catalytic theory based on an intermediate or variable oxidation states. Candidates often managed the final mark for lowering the activation enthalpy.

**3(e)(i)** Mostly well done although some did not appreciate that measuring pH/acidity would be inappropriate.

**3(e)(ii)** Often good, k very occasionally omitted and  $[H^+]^2$  sometimes omitted.

**3(e)(iii)** Most talked in generic terms about evaporation and hence loss of reactants leading to a decrease in rate, thus only gaining 1 mark.

A few realised the significance of bromine loss and how the rate would appear to decrease because of lower absorbance readings.

#### Question 4

**4(a)** All parts were mostly correct, although in (ii) ‘esterification’, ‘ester’ and ‘copolymer’ were not uncommon.

**4(b)(i)** A careful reading of the question was very important here and many candidates lost marks because they failed to spend enough time considering what was being asked of them. To this extent, not all of the IMBs were named in each polymer, often just the strongest. Precision in answers to these types of questions where a comparison is called for is most important. Too many candidates still think that polyesters possess hydrogen bonds. Also, there seems to be a perception that if a substance possesses hydrogen bonds then permanent dipole-permanent dipole bonds are absent.

**4(b)(ii)** Exceptionally well done. Sometimes ‘chains were stretched’ resulting in ‘more bonds’.

**4(c)(i) and (ii)** Mostly correct although in (ii) some errors due to careless transcription of the diamine structure using just 5 Cs.

**4(c)(iii)** Poor, most just rephrased the question and did not refer to what additions to the chain caused the solubility of the polymer in water.

**4(c)(iv)** Most scored both marks usually with ‘safe and better’.

**4(c)(v)** The most common error was not to mention the N atom.

#### Question 5

**5(a)(i)** Answers usually included 3 groups but some candidates perhaps seeing two marks thought two would do. Occasionally the aldehyde group was called a carboxyl.

**5(a)(ii)** Well known, only a few managed to get the oxidation state of chromium wrong.

**5(b)(i)** Generally, well done, the usual error was not to mention either the bond responsible for the peak or what group it was from. If the candidate had identified carboxylic acid in (a)(i) then it often reappeared here and vanillin was chosen as the white powder.

**5(b)(ii)** What the nature of the peaks are and their labels is not commonly understood although candidates do recognise the basics of mass spectrometry. The main weakness was the inability to determine the molecular formula from the structures given and hence the expected molecular mass.

**5(b)(iii)** Again another question more care in reading the rubric would have benefited candidates. Many candidates started by describing the characteristics of a good solvent for recrystallisation but failed to apply that to the properties of water with respect to dissolving the material at high and low temperatures. A common error was not to filter to collect the recrystallised apocynin and/or not managing to spell crystals etc. correctly.

**5(c)** Usual errors were not drawing the intermediate, not knowing the final structure around the carbonyl and the formula of the cyanide ion. The use of curly arrows was one of the better aspects of this question. Some decided that nucleophilic attack took place at the phenolic carbon.

## F335 Chemistry by Design

### General Comments:

There was, as usual, a wide range of marks from scores below 20 to marks in three figures. Many candidates showed good understanding in certain areas but less in others. Something that was noticeable, even in the scripts of those not scoring well, was the amount of effort that was being put into all the answers, even at the end of two gruelling hours. Very few candidates seemed to have trouble completing the paper.

In this day of word processing, it is perhaps hardly surprising that the handwriting of some candidates is poor – they get so little practice. However, they must be able to write legibly when they need to.

From the dawn of time, teachers have been urging candidates to ‘read the question’, sometimes more forcibly. This failure to answer the question set was particularly noticeable on occasions this year as will be illustrated below.

Candidates must realise that Chemists are very particular over the use of technical terms. Thus ‘nuclear charge’ is not the same as ‘ionic charge’ (2a(ii)), each *atom* does not have a unique emission spectrum (4c) and many more examples. It is a shame when candidates appear to know what is going on but do not express themselves sufficiently clearly to gain marks. They must practise this skill.

This is the last ‘final module’ for mainstream candidates. The tradition of asking questions in context will, of course, continue in the new H433 series.

### Comments on Individual Questions:

#### Question 1

**1(a)(i)** Most candidates wrote the correct  $C_{10}H_{12}O$  but there were some errors.

**1(a)(ii)** Many candidates wrote ‘ether’ but some gave ‘alcohol’ and others did not read the need to name a saturated group and said ‘alkene’.

**1(a)(iii)** Most represented the *E* isomer correctly using a structural, rather than a skeletal formula.

**1(b)** This was usually correct, including the ether group.

**1(c)(i)** Some candidates produced very polished mechanisms. Others were not careful enough as to where their curly arrows started. They must start either from a bond or a lone pair (the negative charge on the bromide ion was accepted). The first mark was the hardest to score with some drawing arrows to the alkene from the bromine.

**1(c)(ii)** A few candidates got the idea that the bromine electrophile had to attack first followed by the water nucleophile. However, many failed to gain the second mark by referring to hydroxide ions rather than water molecules or hydroxyl groups.

**1(d)** Scoring was high here which is encouraging. Some glossed over the idea of a lone pair on oxygen attracting a partially positive hydrogen. Most realised that anethole would hydrogen bond with water as it had an ether oxygen. Many scored for saying ‘few hydrogen bonds’ or addressing the partial solubility in a myriad other acceptable ways. The mark least scored was for saying that hydrogen bonds in water were broken.

**1(e)(i)** Some candidates realised that the bromo derivative was the intermediate and used HBr to form it and ammonia to react with it. Many candidates benefitted from the decision to mark the three points separately, particularly the ammonia mark.

**1(e)(ii)** Many candidates correctly protonated the amine group but some added chlorine atoms to the chain or to the ring.

**1(e)(iii)** There was high scoring here, the commonest error being to omit 'anethole *doesn't* have a carbon attached to four different groups'. Diagrams from 1eiv were allowed in awarding the 'which C and which four groups' mark which allowed a lot more candidates to gain marks.

**1(e)(iv)** Most were able to draw the correct diagrams, though some used the wrong structure for X. Candidates must realise that two 'lines' opposite each other do not represent a three-dimensional structure.

**1(e)(v)** Many either quoted the absence of a C=C bond or the presence of an N-H bond; some gave both, as required.

## Question 2

**2(a)(i)** This was well done with many candidates labelling all the energy levels correctly and working out the correct value for the enthalpy change of solution.

**2(a)(ii)** Most recognised that the crucial factor was the greater charge on the calcium ion. The rest was a matter of careful expression, avoiding imprecise answers like 'more bonds to water'.

**2(b)** This question was well done with almost all candidates scoring one mark and most scoring two (for showing the partial polarisations of the atoms in water). The previous error, HO<sub>2</sub> was hardly ever seen.

**2(c)** Some candidates worked out the moles of CaCl<sub>2</sub>, multiplied this by 1.5 to get moles of particles and then by 3.7 to get the depression. A common error was to omit the factor of 1.5. Others got the *M<sub>r</sub>* ratio up the wrong way.

**2(d)(i)** Most managed to unravel the equations given to get the overall equation for the reaction between calcium carbonate and sodium chloride to give sodium carbonate and calcium chloride.

**2(d)(ii)** This was another high-scoring question with most candidates spotting that it was 100% atom economy and that this resulted in no waste. Comments like 'little waste' did not score.

**2(e)** A gratifyingly large number of candidates could name sodium hydrogencarbonate and ammonium chloride. Occasional errors were to put oxidation states after the carbonate or the ammonium.

**2(f)** Defining entropy presented few problems. Many spotted that a gas was evolved but fewer clearly stated that gases had higher entropy than solids.

**2(g)** This calculation was often done correctly. Negative answers scored few marks.

**2(h)(i)** Some candidates realised that they were to answer the question and gave the equilibrium for the ionisation of NH<sub>4</sub><sup>+</sup>. Others gave an alternative equilibrium or the expression for *K<sub>a</sub>*.

**2(h)(ii)** Often in spite of wrong answers to part (i), many candidates got back on track here and correctly calculated this pH.

**2(h)(iii)** Some gave good answers based on their understanding of buffer solutions. Adding  $H^+$  caused the equilibrium position of the (correct) equilibrium in (i) to move to the left so the pH remained virtually unchanged because the concentration of  $NH_3$  was high.

**2(h)(iv)** Many got the correct answer by using  $[H^+] = K_a \times [NH_4^+]/[NH_3]$ . The main cause of error was to get the ratio up the wrong way.

*Numerical answers: 2a(i) – 120 kJ mol<sup>-1</sup>; 2c – 2.9°C; 2g 423 K; 2h(ii) 5.63; 2h(iv) 9.55.*

### Question 3

**3(a)(i)** Most agreed that there should be no units because the units cancelled.

**3(a)(ii)** Most noted that the  $K_c$  was lower at higher temperature and stated that this pointed to an exothermic forward reaction. The main error was to forecast an endothermic reaction in spite of this.

**3(b)(i)** This was a question where candidates' powers of expression were tested. Some correctly explained the given value for  $[H^+]$  by saying that only a small amount of CO was left and that the ratio of CO initially to hydrogen was 1:1. Other answers, especially using numbers, were more elegant. Sometimes it was not clear what the ratio referred to, or water was mentioned instead of hydrogen.

**3(b)(ii)** Here most candidates spotted that  $[H_2] = [CO_2]$  at equilibrium. Many went on to do the calculation correctly. Very few realised that, since one piece of data was to one significant figure, this was the 'appropriate' value for the answer. This significant figure mark was one of the least likely to be scored on the whole paper.

**3(b)(iii)** Many recognised that the pressure would need to be smaller than 1 atmosphere to get this concentration and obtained the correct answer. Quite a number got the reciprocal of the correct answer.

**3(c)** Some candidates correctly defined activation enthalpy as the energy needed by a pair of particles to react when they collided, went on to say that catalysts provided a route of lower activation enthalpy and finished by saying this meant more frequent successful collisions. Scores of three were rare, however, with the catalyst mark being scored most, followed by the activation enthalpy mark. Ideas of collision were often lacking in both the first and third marking points and the idea of frequency in the third.

**3(d)(i)** A few candidates managed to negotiate this tricky dot-and-cross diagram, showing a dative bond from the nitrogen to one oxygen and a double bond to another, with a single bond to the oxygen with the 'extra' electron (shown in a variety of ways). Many 'expanded the octet' which nitrogen cannot do. They and others benefited from an intermediate mark for 'five electrons round the N atom' which was widely scored. The oxidation state was almost invariably correct.

**3(d)(ii)** Many could derive the equation and, of these, most could name and describe the dinitrogen monoxide formed. Some thought that oxygen ought to feature in the equation.

*Numerical answers: 3b(ii)  $1 \times 10^{-3} \text{ mol dm}^{-3}$ ; 3b(iii) 0.036 atm;*

### Question 4

**4(a)(i)** This was well done with most candidates giving +3 as the oxidation state and  $2p^6 3s^2 3p^6 3d^5$  as the configuration.  $3d^3 4s^2$  was rarely seen.

**4(a)(ii)** Many correctly calculated the moles of water (and anhydrous salt) as 0.012 and obtained the correct answer of  $n=1$ . It was often difficult to see the method of those who got another answer for  $n$ .

**4(a)(iii)** A very few candidates managed to get through this tricky calculation, usually spotting that 0.926g of  $\text{Fe}_3\text{O}_y$  represented 0.004 moles, which led to  $y = 4$ .

**4(b)(i)** Most candidates managed to name an appropriate colour (yellow or green) and say that it was reflected. Just a few answers of 'purple' were seen.

**4(b)(ii)** Many candidates correctly stated that the d energy levels were split and that electrons were excited to a higher energy level. This absorbed light where  $\Delta E = hv$ . The complementary colour was reflected. Trips and slips were using 'D' rather than 'd' to describe the energy levels; not saying where the electrons were excited to; not mentioning  $\Delta E = hv$  or not making it clear that the frequency was *proportional* to the energy (some confusion between wavelength and frequency was also noted); and not saying that the complementary frequencies were *reflected* (or transmitted).

**4(c)** Some candidates said that a line spectrum was coloured lines on a black background and that each element had a unique spectrum. Iron could be identified in ochre by comparison with a known iron spectrum. Many went into detail about how the spectrum was formed, which was not required by the question. Some omitted a description of the spectrum while others were not clear that the spectra were unique to *elements*, not atoms or compounds.

**4(d)(i)** Many candidates gave the correct formulae of the triester and the 'glycerol'. Fewer gave the formula of the salt but many lost this mark for simply not putting '3' before the 'KOH'.

**4(d)(ii)** This was high-scoring with most candidates giving the correct ester formula and displaying all the bonds.

**4(d)(iii)** Some candidates correctly gave 'methanol and concentrated sulfuric acid' but the 'methanol' was relatively rare.

**4(e)** Most gave a suitable inert gas and many mentioned 'high-boiling liquid'. Some gave a unit of time but this was a place where 'read the question' was paramount with the majority not appearing to notice the word 'units'.

*Numerical answers: 4a(ii)  $n = 1$ ; 4a(iii)  $y = 4$ .*

## Question 5

**5(a)** Most realised that hydrogen bonding was the key but not all mentioned the nitrogen atoms in this context.

**5(b)(i)** Many circled the correct structure, omitting the methyl group, which was impressive. Including the methyl group was the common error.

**5(b)(ii)** There were some good, well expressed, answers here. Many stated that the pharmacophore had the same shape as the substrate and thus fitted into the active site of the enzyme, competing with the substrate. C fitted better which made it more specific. Some omitted reference to shape or said that the shape was complementary to the substrate or the same as the active site. Many wrote that C had an extra methyl group without further detail.

**5(c)(i)** Most gave concentrated nitric and sulfuric acids and below 55°C. The commonest error was to omit the 'conc'.

**5(c)(ii)** This was another 'read the question' moment. The question asked for '**names**' but many gave formulae. The question was asking candidates to interpret the formulae on the Data Sheet.

**5(c)(iii)** Most knew 'amide' and many thought erroneously that the reagent was benzoic acid. 'Error carried forward' was available for the name, but many got it wrong. The correct reagent was benzoyl chloride and few got this and even fewer got both name and formula.

**5(d)(i)** Most got this correct ( $C_{10}H_9N_3$ ).

**5(d)(ii)** A few candidates correctly worked out that there were six peaks and labelled the structure correctly. Those who thought that there were three equivalent protons on each ring were often able to gain partial credit through the mark-scheme.

**5(e)** This was well answered though most got the correct angle of  $109^\circ$  caused by four areas of electron density, fewer realised that the shape around the nitrogen atoms was pyramidal, not tetrahedral. The diagram clearly took candidates out of their comfort zone but many who attempted it got an acceptable structure.

**5(f)** Most realised that they were basically describing benzene. Almost all said 'delocalised' and many said 'two rings above and below the plane of the C-N ring'. There were again problems of communication, for example 'a ring, above and below...'. Some realised that each C and N atom contributed one electron.

# F336 Chemistry Individual Investigation (Coursework)

## General Comments

The vast majority of candidates made good use of the opportunity provided by this assessment component to demonstrate their skills in planning, carrying out and evaluating their own investigation.

Investigations involving chemical kinetics continued to be by far the most popular topic chosen by candidates. Many investigations involving the synthesis and analysis of aspirin and the analysis of brass were also seen.

In general, Centres seemed well versed in the application of the marking descriptors and recommended appropriate marks. In a few cases, Centres with mainly high scoring candidates were a little harsh when marking candidates with relatively modest investigations while Centres with few high scoring candidates tended to be more generous when marking relatively modest investigations.

In examples of good practice students' work was comprehensively annotated but in other cases the candidate summary sheets were filled with stock phrases taken from the marking criteria such as 'describes comprehensive range of chemical knowledge'. This resulted in them giving impersonal, generic comments which, in some cases, were duplicated in several scripts.

In some cases, the candidate name and/or candidate number was missing from the investigation report. In a small number of examples the wrong candidate number was used. Centres should take great care to ensure that all pieces of work are correctly and uniquely identified.

OCR provides a free Coursework Consultancy service, which allows teachers at the Centre to obtain guidance on their marking from the Principal Moderator before marks are submitted to OCR. In centres where there is a wide difference between the marks awarded by the centre and the marks achieved after moderation the use of the service is highly recommended. Details are to be found on Coursework Enquiry forms, available from Interchange.

## Skill Area A

In most cases the marking criteria were accurately applied. It was quite common for students to include a lot of material that was not relevant to the investigation undertaken. Such work did not contribute to the mark achieved.

## Skill Area B

This skill area was also generally well-marked with centres applying the marking criteria in an appropriate manner. A good way of checking whether the method is sufficiently comprehensive is to ask whether a fellow student could use it as a set of instructions to repeat the experiment.

## Skill Area C

The standard of marking of the skill area varied between centres. Some candidates did not include concentrations of solutions in their risk assessment or explain the content of the resources that they had used but the marks awarded did not reflect these omissions. In contrast a few Centres put undue emphasis on grammar and spelling and were too harsh in their award of marks.

### **Skill Area D**

Most candidates produced clear, well tabulated results. In a small number of cases the amount of data recorded was significantly less than that expected from 18 hours spent in the laboratory on a particular type of investigation. This tended to apply to all candidates within the centre.

### **Skill Area E**

The skill of graph drawing is now much improved with many candidates providing hand drawn graphs with appropriate lines of best fit. There are still a few candidates who use small, computer generated graphs in kinetics based investigations when a larger, hand drawn graph would have been more accurate.

The ability to draw appropriate conclusions discriminated between candidates. Better candidates used the theory they had described in skill A to explain what they could find out from their experimental results. Lower scoring candidates tended to simply describe their results rather than attempting to draw conclusions from them.

### **Skill Area F**

The marks awarded in this section were reasonably accurate. Most candidates were able to identify some limitations in their experimental procedure although this part of the report was sometimes quite brief and some limitations were not really relevant. Some candidates did not appreciate that they should calculate the percentage error in every type of measurement they had taken.

### **Skill Area G**

Too many centres failed to include the expected documentation to justify the marks awarded in this skill area. In some cases, the high marks awarded in this skill area were surprising in view of the poor quality of data recorded in skill D.

### **Skill Area H**

There were a significant number of Centres where the marks awarded were too generous in this skill area.

Some Centres did not sufficiently appreciate that to be awarded maximum marks candidates need to show real flair in their ability to innovate and solve problems. This mark should not be awarded simply because the candidate has chosen to study a topic that is not in the specification or where they have not yet reached the topic in their studies.

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