

Chemistry A

Advanced GCE A2 H434

Advanced Subsidiary GCE AS H034

OCR Report to Centres

June 2012

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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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Overview

General comments

Written papers

The AS units mark the transition from GCSE to A level standard and examine a wide range of knowledge and skills that are essential for the study of chemistry. In both F321 and F322, the responses of many candidates were pleasing and showed that good examination preparation had taken place.

Across all AS and A2 units, there was clear evidence that candidates have used the mark schemes from previous examinations to inform their revision. However, candidates need to take care to read each question carefully and to check what is actually being asked. It is always disappointing for an Examiner to see a perfect response that might be an answer to a different question to the one that was asked.

Practical Tasks

Candidates continue to display high levels of skill in observing, recording, analysing and evaluating. The Tasks continue to provide an effective tool in assessing candidate competency and should provide sufficient discrimination to arrive at a suitable set of marks for candidates within centres and the national cohort.

Whilst Tasks have been trialled extensively prior to publication it is important that they are trialled in centres before they are sat by candidates. If a centre experiences difficulties with an experiment during trialling they should e-mail OCR at GCEScienceTasks@ocr.org.uk

Application of number

Calculations are frequently well presented, showing detailed working. In general, candidates use calculators proficiently but a common source of concern is a lack of appreciation of the numbers produced. This is most apparent when intermediate numerical answers in multi-stage calculations are over-rounded, only for a final answer to then be given to more significant figures. This process introduces a significant error in the final answer. The most accurate final value will always arise by using a calculator value throughout. Candidates need to consider the accuracy of data supplied and, in Practical Tasks, of any readings taken.

News round-up for GCE Chemistry A

A level reform

Over the last year, the future of A levels has received extensive interest. Ofqual is currently running a consultation to seek views from higher education, employers, learned societies, colleges, schools and others.

There is a link to all the relevant consultations, debates and reports at <http://social.ocr.org.uk/groups/science/conversations/level-questionnaire-and-level-reform> (also see <http://social.ocr.org.uk/groups/science/conversations/level-timelines>). We would strongly encourage teachers to contribute to the consultation (11 September deadline).

Additionally, if you have suggestions of content you would like to see in any revised GCE Chemistry qualifications please e-mail your comments to GCEScienceTasks@ocr.org.uk, we would be very happy to hear from you.

Keep up-to-date with developments in GCE Chemistry

The OCR community, www.social.ocr.org.uk/groups/science, is a useful reference point to help keep teachers up-to-date with GCE Chemistry (and science). I would strongly recommend visiting the site and registering. A selection of posts from the year which may be of interest are for:

- Free drawing software (<http://social.ocr.org.uk/groups/science/conversations/free-chemical-drawing-software>)
- RSC e-membership (<http://social.ocr.org.uk/groups/science/conversations/rsc-e-membership>)
- Changes to the definition of the hydrogen bond (<http://social.ocr.org.uk/groups/science/conversations/recent-chemistry-news>)
- Free e-books for GCE Chemistry A (<http://social.ocr.org.uk/groups/science/resources/free-e-books-ocr-level-qualifications>)
- The Cambridge Chemistry Challenge (<http://social.ocr.org.uk/groups/science/conversations/cambridge-chemistry-challenge>)

F321 Atoms, Bonds and Groups

General comments

The entry was once again pleasingly high. The final entry of almost 23000 candidates showed an increase from the previous June series. The spread of marks achieved by candidates suggested that the paper had questions accessible to all candidates.

As in previous series, the paper examined a wide range of knowledge and skills from within the specification and in the main the responses of many candidates showed that good exam preparation had taken place. As in previous years, it is important that candidates do not rush at questions, being triggered by key words to write down a standard answer without really thinking about what has been asked. Doing this can cause candidates to miss out vital parts of the answer, as was seen in **1(h)(i)** and **4(d)(i)**. This approach was also very apparent in **3(b)(ii)** where few candidates referred to the second ionisation energies that were being compared. In contrast to previous series, however, it was pleasing to see how well organised the answers were to the extended question **2(b)**.

Candidates should be aware that the two Quality of Written Communication marks in this paper are given for appropriate technical terms, spelled correctly. Candidates must make their writing legible to aid the marking of spelling. Also, candidates should use technical terms such as van der Waals' forces, rather than vdWs.

Comments on individual questions

Question 1

(a) The majority of candidates were well rehearsed in this definition and most scored all three marks available. The main source of error was the omission of the idea of a mean mass or referring to the mass of an element instead of an atom.

(b) Most candidates handled this well with few making any errors other than those of wrongly transcribing the percentages. A few also failed to give the answer to the required number of decimal places or rounded 32.092 to 32.10. Only a very small percentage did not know how to attempt the sum.

(c) A significant number of candidates did not score the second mark and made errors in stating the number of each sub-atomic particle present in the sulfur-34 anion. The first line was almost always answered correctly.

(d) Relatively few candidates understood the relationship between the Avogadro constant, moles and atoms to score full marks. Most candidates correctly calculated the number of molecules (7.224×10^{21}) and a few calculated the number of moles of atoms (0.096) but only the better candidates were able to link the number of moles of sulfur molecules with the number of atoms per molecule and the Avogadro constant.

(e)(i) Candidates provided good answers on the whole. Where marks were lost it was usually because of inaccuracies in the description rather than a complete lack of knowledge. Common among such errors was electron movement within a molecule inducing a dipole within that molecule rather than in adjacent molecules.

(e)(ii) This part caused difficulty amongst the weaker candidates. The more able could readily identify a reason, but weaker candidates tended to use irrelevant phrases such as '*...sulfur has no hydrogen bonding...*' or incorrect phrases such as '*...sulfur has no lone pairs...*'.

(f) This was a relatively difficult oxidation number to deduce but many realised that sulfur was in the +2 state. Only a few candidates gave no '+' sign and even less gave the ionic S^{2+} form.

(g)(i) This very straightforward question provided a mark for nearly all candidates. Good candidates wrote '*...No waters of crystallisation...*' and many others simply wrote '*...without water...*', a phrase no doubt covered many times in chemistry lessons.

(g)(ii) Most candidates correctly calculated 248.2. Computational errors were mainly due to the omission of five water molecules (158.2) or for assuming the five in $5H_2O$ referred to the H atoms only (184.2). Bizarrely, 284.2 was frequently seen – presumably a transcription of the value showing on the calculator.

(g)(iii) This question differentiated well. Able candidates scored both marks – weaker candidates failed to realise the need to convert the mass of $Na_2S_2O_3 \cdot 5H_2O$ into moles prior to multiplying by the molar mass of the anhydrous salt (158.2).

(h)(i) Most candidates knew that there were six bonding pairs of electrons but many failed to state that these **pairs** of electrons repelled each other (equally) so missed out on the second mark.

(h)(ii) The definition of electronegativity was sporadically answered. Candidates tended to know that the term meant attraction of electrons but many did not relate this to the electrons being in a covalent bond.

The idea of symmetry causing no overall dipole was described by nearly all, irrespective of how electronegativity was addressed earlier in the response.

Question 2

(a) Most candidates had no problem with this part.

(b) Candidates are clearly using past mark schemes on which to base answers as many split this extended writing into separate sections in a manner similar to previous mark schemes. This led to an improved clarity of answer in which the structure and bonding of each of the elements was clearly described. Where candidates did drop marks it was either by ascribing the wrong type of bonding and so, for example, saying that the bonding in aluminium was ionic, or by contradicting a statement of correct bonding, for example, referring to oppositely charged ions in the metallic bonding of aluminium. Most common of the various errors was a description of molecules or intermolecular forces when describing aluminium and silicon. Another common error that prevented some very sound answers from gaining full credit was to describe Al as metallic but omitting the term '*giant*'.

Candidates who used bullet points tended to score well.

(c)(i) The specification requires candidates to know that there is a general increase in first ionisation energies across a period. Knowledge of minor decreases at aluminium and sulfur are not in the specification but candidates who correctly included these dips did not lose credit. However, some candidates who did attempt to put dips in the increasing trend did lose the mark due to poorly drawn diagrams.

(c)(ii) The idea of decreasing atomic radius was well known.

Question 3

(a) Most candidates answered this part correctly.

(b)(i) The equation was nearly always given correctly but the state symbol mark was frequently lost by omission or use of (s).

(b)(ii) Although the question asked for a difference in second ionisation energies of Mg and Sr, candidates were allowed credit for the group trend in ionisation energies.

The least well scored point was the role of nuclear attraction, which candidates either omitted or used nuclear '*charge*' instead.

(c)(i) This was a relatively challenging question. Many candidates were unclear about how ionic compounds are formed or dissociated in water. A number of candidates omitted strontium altogether and only suggested H^+ and OH^- as ions present in the solution.

(c)(ii) Although some failed to address the question and omitted to mention electrons altogether, simply discussing oxidation in terms of change of oxidation number, most were comfortable with this low demand question.

(c)(iii) This question proved to be challenging for the weaker candidates. Despite this, many did get the right answer. Of the various other possibilities some gave the option of preparing the hydroxide by adding sodium hydroxide to a soluble strontium salt. A number did not get the mark because they restated the equation they had encountered earlier, suggesting the addition of strontium metal to water.

(d)(i) This question was not well answered. Some candidates got close to the answer but referred to the oxidation number of sulfur in the sulfate rather than elemental sulfur, while many candidates assigned (IV) to the strontium. Others simply stated that (IV) referred to the oxidation number without any further details.

(d)(ii) This proved to be one of the most challenging questions on the paper. By far the most common answer given by candidates was to suggest H_2SO_4 as the appropriate acid. Very few realised the correct response was H_2SO_3 .

Question 4

(a)(i) About half of the candidates wrote the correct balanced equation. The formation of only $HClO$ or hydrogen gas instead of HCl was a frequent incorrect response.

(a)(ii) Once again the need to read the question rather than repeat answers seen on published mark schemes was key. The question asked for the problem caused by chlorine compounds and not for chlorine. Many showed responses beginning '*...Chlorine is ...*' and so were not given credit.

(b)(i) Despite a correct precipitation equation seen below, very few were able to describe this reaction as a '*precipitation reaction*'. By far the most common error was to suggest that the reaction was a displacement. Other suggestions were substitution or redox.

(b)(ii) As ever, ionic equations (with state symbols) prove challenging. A frequent incorrect response was $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl$, with the (s) being omitted from $AgCl$.

(c)(i) This was very straightforward for nearly all candidates.

(c)(ii) This calculation was challenging. Candidates were expected to realise that the number of moles of a Group 2 chloride is half that of the moles of silver chloride in part **(i)**. This was only appreciated by a few. Instead the common approach was to assume an equal number of moles.

(d)(i) The question had dative and covalent bond in italics so both terms needed to be described in the response. Many failed to go into sufficient detail and so, although they described why the bonding is called dative, they did not mention a covalent bond.

(d)(ii) Able candidates handled this question with ease but many candidates do not know these ions or specifically the ammonium ion. Many attempted to split the ammonium ion into N^{3-} and H^+ .

(d)(iii) This was a difficult question and many candidates struggled here. Some attempted to make the compound into a single molecule while others forgot the dative covalent bond in the ammonium ion. Candidates are advised to make diagrams large enough and clear enough to read.

(e)(i) Decomposition was better known than precipitation with most candidates gaining the mark. Once again, an array of varied reaction types was seen amongst the incorrect responses.

(e)(ii) Most candidates had a good overall understanding of how to approach this question. Errors did occur, for example, forgetting to use the ratio from the stoichiometry in the equation or incorrectly calculating the relative formula mass of the potassium chlorate. However, overall this was well answered.

F322 Chains, Energy and Resources

General comments

Candidates were able to apply their knowledge to novel situations and were able to demonstrate positive achievement at all levels. There was clear evidence that candidates had used the mark schemes from previous examinations to inform their revision. However, candidates need to take care to read the question carefully to check what is actually being asked. There was no evidence from the scripts that candidates did not have enough time to finish the examination and often the last question **6(b)(iii)** was answered in some detail.

Candidates were able to use the different types of formulae with confidence and there seems to be an increased use of skeletal formulae. Candidates are also more confident in their use of the 'curly arrow' but they must ensure that they do not rush mechanism questions and as a result make careless errors with the placement of the curly arrow. Candidates still need to improve the presentation of their working out so that any error carried forward can be clearly seen and given credit where warranted.

Comments on individual questions

Question 1

(a) Many candidates appreciated that different fractions had different boiling points. Only a very small proportion of candidates referred to fractions condensing at different temperatures.

(b) Candidates often referred to the renewability of biodiesel or bio-ethanol or to the non-renewability of fuels from crude oil. Some candidates gave answers that related to the idea of biofuels being carbon-neutral.

(c)(i) Candidates found this part quite demanding and often repeated much of the information in the stem. Good answers explained that since the bond enthalpies of the C–C bonds present were almost identical, any of the bonds within the chain could break.

(c)(ii) Candidates could often identify alkene **A** as propene either using the molecular ion or appreciating that once propane is lost from $C_{12}H_{26}$ the only alkene that could be made was C_3H_6 . Many candidates could identify the particle responsible for $m/z = 27$ and the positive charge was not omitted very often. Candidates often found the construction of the equation difficult and gave equations such as $C_{12}H_{36} \rightarrow C_3H_8 + C_9H_{18}$.

(d) A small but significant proportion of candidates only answered one part of **(d)**, focusing on making 1,2-dibromoethane and missing out the two other compounds. The electrophilic addition mechanism was well known but candidates still made mistakes involving the positioning of the curly arrows. In particular, many curly arrows did not start from the double C=C bond or from the negative charge or lone pair of the bromide ion. A small proportion of candidates included partial charges on the double bond. Many candidates appreciated that HBr reacted with ethene to give bromoethane and that H_2O reacted with ethene to give ethanol. However, a significant number of candidates did not mention that steam had to be used rather than liquid water. The catalyst for this reaction was well known.

(e) Many candidates were able to draw the shape of an ethene molecule but were not always able to recall the bond angle, with 90° and 109.5° being common incorrect answers. Candidates found the explanation quite difficult and often did not refer to the repulsion of electron pairs or to the number of electron pairs involved.

(f)(i) Many candidates could draw the structure of *E*-pent-2-ene and only a small proportion drew the *Z* isomer.

(f)(ii) The structure of the polymer was often drawn correctly and only a small proportion ignored the instruction about two repeat units and drew a structure with one repeat unit.

Question 2

(a)(i),(ii) Most candidates were able to write the two equations.

(b)(i) Many candidates gave the correct dipoles on the molecule.

(b)(ii) Most candidates understood the idea of a 'curly arrow'.

(b)(iii) Most candidates understood the idea of 'heterolytic fission'.

(b)(iv) Most candidates understood that a water molecule acted as an electron pair donor.

(b)(v) Most candidates appreciated that a proton was present at the start of the reaction and was formed in the last step.

(b)(vi) Candidates found this part extremely difficult and most candidates gave the formula of a diol rather than a methyl ether.

(c) Candidates often did not give a comparative statement and stated that ethane-1,2-diol had two hydroxyl groups rather than **more** hydroxyl groups than ethanol. Weaker candidates referred to van der Waals' forces rather than hydrogen bonding. Only a small proportion of candidates incorrectly referred to hydroxide ions.

(d) Candidates found this part quite difficult although they often included a structure with an ester linkage which was given one mark in the mark scheme. Some candidates did not draw a structure with the correct molecular formula and drew a hydroxy ester.

(e) Although some candidates drew the structures of the correct oxidation products of ethane-1,2-diol, others gave oxidation products of ethanol. A small proportion of candidates drew the –OH in the acid group with the bonding to the hydrogen atom rather than the oxygen atom.

Question 3

(a),(b) Candidates showed a good understanding of Le Chatelier's principle and were often awarded full marks.

(c)(i) Candidates often found it difficult to explain the choice of 30 atmospheres and did not relate this to their answer in **(a)**. As a result they often referred to increasing the percentage yield rather than focusing on the rate of reaction.

(c)(ii) Candidates could often draw the Boltzmann distribution. A small proportion of candidates incorrectly drew two curves, one for a catalyst and one without a catalyst. The most likely error with the Boltzmann curve was on the right hand side where the line often touched the x-axis or incorrect labels of the axes.

(d) Candidates found this part quite difficult and often were not able to calculate the correct answer of 91.2%. A common misconception was to work with both moles and mass when using the equation for percentage yield rather than either using actual mass and predicted mass or actual moles and predicted moles. Candidates were often confused with the units of tonnes.

(e)(i) Many candidates could construct the equation.

(e)(ii) Candidates often referred to the toxic nature of carbon monoxide and the resulting improvement of atom economy that could be obtained by using the carbon monoxide. Only a small proportion of candidates gave uses for methanol as an alternative answer.

(f) Most candidates could recall the need for a nickel catalyst but often did not recall the use of unsaturated fats, instead referring to unsaturated hydrocarbons or alkenes.

Question 4

(a)(i) Many candidates could complete the enthalpy profile diagram. The most common mistake was in drawing the activation energy, either not going to the maximum of the curve or starting from below the enthalpy of the products.

(a)(ii) Many candidates were unable to deduce that the enthalpy change of formation was -46 kJ mol^{-1} and the most common answer was -92 kJ mol^{-1} .

(a)(iii) Candidates often appreciated that the activation energy would be lower than $+250 \text{ kJ mol}^{-1}$.

(a)(iv) Candidates had much more difficulty than in **4(a)(iii)** with few obtaining the correct answer of $+342 \text{ kJ mol}^{-1}$.

(b)(i) The equation for the reaction within a catalytic converter was well known.

(b)(ii) The three stages of adsorption, reaction and desorption were often described in some detail. Only a small proportion of candidates gave absorption instead of adsorption.

(c)(i) The most common modern analytical techniques given were IR spectroscopy and mass spectrometry. Some candidates incorrectly gave examples of monitoring environmental pollution rather than the techniques used.

(c)(ii) Candidates often appreciated that all countries contribute towards pollution or that pollution can travel across borders so that there must be international cooperation in order to reduce pollution.

(d) Candidates were often awarded two marks but sometimes did not appreciate that the overall equation had to be $\text{O}_3 + \text{O} \rightarrow 2\text{O}_2$ and that the second step could not include O_3 .

(e)(i) A common misconception was that nitrogen and oxygen would not react rather than a reaction taking place to give a mixture of nitrogen oxides. A common response was that the activation energy for the reaction is too high. Some candidates suggested that heat was lost during the reaction, an answer to a different question.

(e)(ii) Although some candidates obtained the correct answer of $+82 \text{ kJ mol}^{-1}$, many achieved one mark by error carried forward.

Question 5

(a) Although candidates often obtained the correct answer of -162 kJ mol^{-1} , many made simple arithmetic errors or did not appreciate that bond breaking was endothermic and bond forming was exothermic. Other candidates were not able to count the correct number of bonds broken or formed. Centres should advise candidates to organise their answers to such questions clearly to aid marking.

(b)(i) Candidates could recall that methane molecules absorbed IR radiation but often referred to the molecules vibrating rather than the bonds vibrating.

(b)(ii) CCS techniques were well known by candidates but a common misconception was to refer to carbon rather than carbon dioxide being reacted with metal oxides.

(c)(i) Candidates could recall the names of the three steps, initiation, propagation and termination and often linked these to appropriate equations to be awarded the mark for the Quality of Written Communication. Candidates were more likely to get the initiation step correct than the propagation steps. A common misconception in the propagation steps was the production of hydrogen radicals rather than an ethyl radical or a bromine radical. As a result some candidates wrote termination steps showing hydrogen radicals. Candidates tended to write several termination steps.

A small but significant proportion of candidates used the wrong halogen or the wrong hydrocarbon and these were limited to a maximum of five marks for the question.

(c)(ii) Candidates often could not express their ideas with sufficient clarity and described further reactions taking place without specifying in detail what these further reactions might be.

Question 6

(a) Many candidates recalled that the C–Br bond was weaker than the C–Cl bond, resulting in the more rapid hydrolysis of 1-bromopentane. This was an improvement compared to similar questions in previous examination series where candidates often did not refer to the carbon–halogen bond. Common misconceptions included reference to the reactivity of the halogens themselves or to the electronegativity of the halogens.

(b)(i) Many candidates drew skeletal formulae and sometimes did not include the correct number of carbon atoms. Other candidates drew displayed and structural formulae, all of which were given credit. A significant proportion of candidates did not draw all four isomers. Often the same isomer was drawn more than once.

(b)(ii) The molecular formula for the alcohol was often incorrectly quoted as $\text{C}_4\text{H}_9\text{OH}$.

(b)(iii) Only the most able candidates were able to identify the three unknown compounds. Many candidates were able to use the IR spectrum to identify **D** as a carboxylic acid. Candidates often recognised that **C** must be a primary alcohol as a result of its oxidation to a carboxylic acid.

F323 Practical Skills in Chemistry 1

General comments

There has been another significant increase in the number of candidates being entered for this unit with some new centres adopting this popular scheme of assessment as well as an increase in entries from some of our existing centres.

It is clear that teachers and lecturers have a good appreciation of how to operate the scheme within their centres and of the paperwork required for the successful submission of the moderation sample. In many cases, centres provide an accurate set of marks, evidence through their moderation sample that the work has been clearly assessed, details of their centre results and the required CCS160. The best centres show detailed annotation of the submitted work which clearly informs the Moderator of how the marks have been arrived at along with an indication of an internal moderation process. These centres are thanked for the time and effort that goes into ensuring that the sample submitted to their Moderator can be dealt with efficiently and effectively.

Unfortunately the work provided by some centres is not easy to deal with, mainly as a result of essential information being omitted from the work submitted. Centres are reminded that the sample provided should consist of the following:

- All the work requested by the Moderator (one Qualitative, one Quantitative and one Evaluative Task should be provided for each candidate in the sample. Centres should not send more than one Task in each skill area for any one candidate).
- Centre results obtained by the teacher and/or a technician (for centres with more than one teaching group, it is essential that it is clear which centre results have been used to assess the accuracy marks for each candidate).
- One CCS160 (Centre Authentication Form) which confirms that the work has been assessed in such a way as to meet the assessment regulations.
- Any correspondence from OCR.

The vast majority of the work sampled was marked clearly and effectively enabling the Moderator to easily see how the marks had been awarded by the centre. However, in a small number of cases the Moderator found clerical or transcription errors which required the centre being contacted in order to correct these. It is essential that centres have a procedure when arriving at the final marks for their candidates that checks for this kind of error. It must be emphasised that it is the centre's responsibility to ensure that the marks submitted reflect accurately the work of their candidates.

A further problem for Moderators is when the marks awarded by the teachers in the centre are inconsistent. It is vital that centres carefully check the mark schemes and additional guidance before awarding marks and put in place a process of cross moderation within the centre to check that all teachers in the centre are applying the mark schemes in the same way.

Candidate performance

On the whole, candidates appear to be well prepared for the Tasks, displaying high levels of skill in observing, recording, analysing and evaluating. Calculations are frequently well presented, showing detailed working and giving answers to an appropriate degree of accuracy. Candidates do not appear to find rounding answers easy and many candidates lose marks for over-rounding their answers too early in multi-stage calculations.

The Tasks continue to provide an effective tool in assessing candidate competency and provide sufficient discrimination to arrive at a suitable set of marks for candidates within centres and the cohort as a whole. Many centres appear to complete two Tasks from each of the skill areas providing candidates with at least one opportunity to improve their marks.

Qualitative Tasks

The Tasks performed equally well with many of the most able candidates scoring close to full marks.

The Qualitative Task still proves to be difficult for candidates who frequently find it hard to verbalise their observations. It is essential that candidates are aware of the difference between a precipitate and a solution and give both a colour and a physical state when recording their observations. Examples of observations given by candidates in this year's sample are given below:

- *'The reaction went white and a precipitate is formed...'*

This does not communicate that the precipitate is white and does not gain credit.

- *'...A clear solution was observed and some of the solid was left at the bottom...'*

This does not communicate a colourless solution and that the solid has dissolved.

Candidates should also be encouraged to follow instructions carefully and record all of the required changes. This is particularly important when more than one observation is required for one mark.

Centres must trial all of the Tasks carefully and check that the centre results agree with the mark schemes before allowing candidates to attempt a Task. Tasks have been trialled extensively prior to publication and it is unlikely that the results provided cannot be obtained. However, in exceptional circumstances the advice below should be followed.

If teachers are unable to obtain all of the marking points themselves with their trial results (having checked the solutions have been made up correctly), their observations should be submitted by e-mail to OCR for advice at GCEScienceTasks@ocr.org.uk.

It is essential that the mark scheme is carefully followed, for instance,

- When an observation states that a reaction occurs after a delay, *'...less precipitate is formed...'* is not a suitable alternative.
- When the mark scheme requires multiple observations, no mark can be awarded if any of the required observations are missing.
- Equations must be as given in the mark scheme and should be balanced with state symbols when specified to gain the marking point.

Quantitative Tasks

The same issues arise each year with this skill area:

- Centres are reminded that look-up tables are provided in the relevant Task zip folders to help when assessing accuracy.

- Centres should not credit answers which do not conform to the significant figures, decimal places or whole number requirement of a question.
- Titration, mass and temperature readings must be quoted to the degree of precision given in the question and should be consistent.
- Calculations should be checked to ensure that the candidate has completed the Task correctly.
- Centres should check and obtain centre results before allowing candidates to complete the assessment.

On the whole the work of candidates was completed to a very high standard and it was clear that many candidates demonstrated proficiency in both the performance of the Quantitative Task and in the treatment of the results obtained from their practical work.

Evaluative Tasks

There was an improved performance by candidates on the Evaluative Tasks in comparison to candidates entered in previous series.

Many candidates dealt easily with calculating errors and assessing the accuracy of different apparatus used within a particular exercise. It is clear that this skill is now well embedded into teaching schemes.

There were a few areas in the marking of Tasks which were of concern to the Moderators. Examples are given below:

- Where candidates are asked to assess and explain how an experiment could be improved or changed, the explanation given for the change should be linked to the change given.
- When dealing with spectra, candidates can only be credited if the ranges and absorbances are related to the correct bonds.
- Calculations can only be credited if answers are rounded correctly.

F324 Rings, Polymers and Analysis

General comments

Generally candidates seemed well prepared and found most parts of the paper very accessible with very few blank spaces left by candidates. The paper discriminated well with a full range of marks being scored and there were some very high scoring candidates.

Pleasingly it seemed that notice had been taken of some of the points promoted in previous reports as there seemed to be fewer errors made in structures by leaving out hydrogens (which is very important given the increasing use of skeletal formulae and mixed varieties involving skeletal formulae and symbols) and with connectivity. Most papers were legible and relatively easy to mark but there were some very disorganised and untidy attempts at the spectra question.

Comments on individual questions

Question 1

(a) Many candidates scored two or three marks but relatively few gained all four marks. The most common error was not mentioning localised π bonds/electrons in the alkene. A proper comparison of the electron density of benzene and an alkene was sometimes missing. Charge density was quite often discussed rather than electron density. It was also disappointing to see some discuss electronegativity instead. A minority of candidates decided to compare the reactivity of phenol with benzene, perhaps illustrating the dangers of placing too much reliance on previous mark schemes.

(b)(i) This was generally well answered although some candidates substituted bromine into the ring – thus also sacrificing marks in **(b)(iii)**. Others placed both bromine atoms on to the same carbon in the side chain but they were allowed to gain marks in **(b)(iii)**.

(b)(ii) Generally well answered.

(b)(iii) Most answered this part well although a minority put extra bromines on the side chain and others made multiple substitutions in the ring.

(b)(iv) Quite a few candidates thought one or both of these reactions were nucleophilic. Others did not specify and simply described them as addition and substitution.

Question 2

(a)(i) Photodegradable or its alternatives were well known. However, bacteria and water were not uncommon suggestions. A small minority thought it was about waste disposal methods and suggested combustion or incineration.

(a)(ii) The majority of candidates were able to draw the correct skeletal structure but some missed either the CH_3 or an OH . Connectivity was tested here with OH^- (instead of HO^-) not being accepted on the first carbon atom.

(b)(i) The most common error was not mentioning ethanol or suggesting an aqueous solution. A surprising number suggested ammonia and HCl .

(b)(ii) This proved more difficult for candidates and many failed to identify the lone pair of electrons on the nitrogen atom as being the key to explaining the basic nature of the amine group. The formula for the salt commonly had chloride ions missing.

(b)(iii) This was usually well answered with only the occasional missing H or end bond. It was pleasing to see that most obeyed the instructions and only drew one repeat unit.

(c)(i) The first zwitterion in the mark scheme was very commonly given but the second zwitterion caused problems with a large proportion of answers showing protonation of both amine groups.

(c)(ii) Good answers were rare. Most vaguely referred to differences in the R group without specifically mentioning which zwitterion would have the higher pH.

Question 3

(a)(i) The double bond was often in the wrong place, usually when the candidate had started counting from the wrong end of the chain. Many candidates struggled to find words to explain the difference between *cis* and *trans* isomers. Those who included a simple diagram in their answer were generally awarded the mark. Others successfully distinguished between *cis* and *trans* by describing the ease of packing of the molecules.

(a)(ii) This straightforward question was well answered, although there were some references to increased cholesterol without the required further qualification.

(b)(i) Most correctly found the number of carbon atoms.

(b)(ii) This was very challenging and only the best candidates managed to identify the correct number of chiral centres.

(c)(i) Many candidates were able to state the two correct functional groups. However, errors were common including the use of methyl, phenyl, phenol and ketone. Hydroxyl was often given instead of alcohol.

(c)(ii) Surprisingly many candidates failed to score this mark. The most common answers, which did not gain credit, referred to stereoisomers (could be *E/Z*) or just isomers rather than optical isomers.

(c)(iii) This proved difficult for many candidates. A common mistake was to use an oxidising agent in **step 1**, while others did gain a mark by correctly mentioning NaBH₄. Many misread the skeletal formula provided and suggested that a ketone would be reduced. A common error in otherwise good answers was to omit the names of the functional groups concerned. However, a significant minority of candidates scored all four marks.

Question 4

(a) There has been a noticeable improvement in answers to mechanism questions over recent series and most candidates were well-prepared for this question. Marks, when lost, were often for curly arrows not starting at the correct place or for the wrong orientation of the 'horseshoe' in the Wheland intermediate. Other errors seen included missing the final catalyst equation, the positive charge missing from NO₂⁺ and a 1,4- rather than 1,3-disubstituted organic product.

(b) This proved difficult although marks could be gained for the salt or benzoic acid and phenylmethanol. Few obtained the third mark for the fully correct balanced equation.

(c) This also proved challenging. A good number of candidates did manage to successfully identify one or other, or both of the first two structures. However, a correct third structure was rarely seen; most candidates not appreciating the significance of excess benzaldehyde being stated in the question. Some otherwise correct structures were not awarded a mark due to missing hydrogen atoms.

(d)(i) This was generally well answered, although it was common for candidates to lose the first mark by not starting the arrow from the negative charge or from a drawn lone pair of electrons. A few candidates missed the δ^+ and δ^- from the C=O bond and a few did not put a negative charge on the oxygen atom in the intermediate.

(d)(ii) This part was accessible to most candidates although a minority of answers did not include lithium in the formula.

Question 5

(a)(i) This proved to be surprisingly difficult for candidates to gain the mark. Perhaps, again, it seemed many candidates had studied a previous mark scheme and referred to fragmentation patterns and suggested reference to databases. Correct references to both the number of peaks/retention times and the peak areas/heights/sizes were not common.

(a)(ii) Most candidates scored this mark.

(b) This question gave good candidates the opportunity to show what they were capable of and there were many good answers. The question discriminated well between candidates and good numbers managed to get full marks. In some cases candidates drew more than one structure without clearly identifying which was their final one. The ester link in the structure was occasionally reversed and many candidates only gave a fleeting consideration to the molecular ion peak and failed to relate the M_r of 164 to an actual molecular formula or structure. The most common omission was not to use the integration information, especially in connection with the peak at $\delta = 7.3$ ppm which required an answer indicating C_6H_5 not C_6H_6 . Also the peak at $\delta = 2.2$ ppm was often suggested as being due to HC=O or HC-C=O with no further information being given.

F325 Equilibria, Energetics and Elements

General comments

Overall the standard was impressive. There were a number of questions where very many candidates collected most of the available marks.

These parts included:

- Weak acids: **3(a)(i),(ii),(iii)**
- Initial rates: **4(a)**

The questions that discriminated the most were those that assessed application of knowledge and understanding or requiring precise responses.

These parts included:

- Novel contexts: **5(e)(ii); 6(d)(i),(ii); 7(b)**
- Equations: **3(b)(i),(ii); 5(c)(ii); 6(c)**
- Precise use of technical language and formulae: **1(b)(i),(d); 5(b)**
- Comparisons involving negative values: **1(c); 4(b)(iii)**

Two parts deserve special comments:

1(d), requiring explained comparisons of lattice enthalpies. Many candidates did not use correct technical terms to describe the particles involved. Too often the word '*ion*' was substituted for '*atom*' or in some cases '*molecule*'. The use of correct technical terms is important when explaining chemical phenomena and it is disappointing to see such basic errors in scripts of candidates at the end of an A level Chemistry course. Significantly these same errors are also common in F321 papers.

3(c), requiring an understanding of buffer solutions. The first part required an explanation of why a buffer solution had been formed using provided information. It was common to see well-rehearsed responses explaining what a buffer solution is and its detailed mode of action. This was all good chemistry but not the answer to the question set.

The second part required candidates to calculate the pH of the prepared buffer solution. The majority assumed that the active ingredients for the buffer were the chemicals used to prepare the buffer. Although some credit was available for such an approach, it was disappointing that so many missed the whole point of the question.

A final general comment should be reserved for the quality of the responses seen by the best candidates. It was impressive to see the outstanding depth of understanding demonstrated by these candidates.

Comments on individual questions

Question 1

(a) Most candidates were awarded both marks for a clear definition stating that one mole of an ionic compound is being formed from its gaseous ions. Some candidates instead included one mole of gaseous ions or gaseous elements.

(b)(i) Many candidates successfully completed the Born–Haber cycle to obtain all marks. Correct species and state symbols are essential in such cycles and marks could not be awarded for species such as $F_2(g)$ or $F(g)$ when $\frac{1}{2}F_2(g)$ was required. Aqueous ions were often a starting point. The commonest omission was the absence of an electron on formation of $Li^+(g)$. Candidates are advised to ensure that the state symbols (s) and (g) are clearly distinguished.

(b)(ii) Most candidates correctly calculated the lattice enthalpy as $-1046 \text{ kJ mol}^{-1}$. Occasional errors were seen with signs, doubling/halving F_2 values or incorrect transcription of the values in the question.

(c) Most candidates found this part difficult, partly from the difficulty of comparing negative numbers. A statement that $\Delta G < 0$ was insufficient as the question required a comparison of ΔH with $T\Delta S$. The best responses stated that ΔH was more negative than $T\Delta S$.

(d) Only the very best candidates produced a cohesive response using correct technical language. Many correctly compared the sizes of the halide ions. Most compared the charges on magnesium and sodium ions but fewer candidates compared the sizes of the cations. The third mark for comparing attractions between the relevant ions proved to be the most difficult and it was insufficient to compare bond strengths or closeness. Throughout the response, it was common to see ‘atoms’ or ‘molecules’ used instead of ions.

Question 2

(a)(i),(ii) Most candidates showed a clear correct K_c expression with corresponding units and it was rare indeed not to be awarding the marks here.

(a)(iii) The correct numerical value of 0.95 was seen on the majority of scripts. The commonest errors arose from incorrect equilibrium moles or poor calculator skills when processing the equilibrium moles. Candidates are advised to show their working clearly, preferably in a tabular format.

(a)(iv) Many candidates were able to relate their calculated value to **(a)(iii)** to the position of equilibrium. The best responses identified that the equilibrium position would be just left of centre.

(b)(i) The best explanations recognised that pressure had no effect on K_c but that K_c would be decreased by the exothermic nature of the forward reaction.

(b)(ii) Most candidates identified that increased temperature and pressure would shift the equilibrium position in opposite directions. Many also explained the reasons for these shifts. Comparatively few explained that the actual shift was difficult to predict as it would be uncertain which effect was the more dominant.

Question 3

(a)(i) Most candidates were awarded this relatively easy mark. When confronted with unfamiliar chemicals, candidates are advised to check carefully that the formulae have been written down correctly as the absence of a subscripted 2 in $(CH_2)_2$ in the formula of either the acid or ion was the commonest mistake.

(a)(ii) Most candidates produced the correct pK_a value of 4.82. pH and pK_a values should typically be shown to two decimal places.

(a)(iii) Most candidates obtained a correct pH of 2.71 with comparative ease using the stock method for calculating the pH of a weak acid. The commonest mistakes were mathematical errors from a correct expression or showing the pH to one decimal place.

(b) Only the best candidates were able to arrive at correct ionic equations in **(i)** and **(ii)**. Many candidates did not show ions separately with, for example, $\text{CH}_3(\text{CH}_2)_2\text{COO})_2\text{Mg}$ being shown rather than $2\text{CH}_3(\text{CH}_2)_2\text{COO}^- + \text{Mg}^{2+}$. The carbonate ion was often seen with an incorrect charge as CO_3^- . The most successful responses showed the reactions of Mg and CO_3^{2-} with H^+ ions rather than with butanoic acid.

(c) In **(i)**, many gave a correct equation/formula for formation of sodium butanoate and then identified that the acid was in excess. Many did not realise the significance of the information in the question, instead defining a buffer and providing a thorough explanation of how a buffer acts.

In **(ii)**, the pH of the resulting buffer solution was required. In their calculations, many candidates used the initial concentrations of butanoic acid and sodium hydroxide to obtain an incorrect pH of 4.12 which received partial credit. Only the very best candidates calculated the concentrations of butanoic acid and butanoate ions in the resulting buffer solution and obtained a correct pH value of 4.22 for all marks. The weakest responses used an incorrect pH method such as that for a weak acid or a strong alkali.

(d) Most candidates showed an acid–base equilibrium involving proton transfer and then identified the acid–base pairs. A common error was the absence of a positive charge on the acid species formed. The acid–base pairs were usually correctly identified but the proton transfer was often shown the wrong way round.

Question 4

(a)(i) For almost all candidates, this part provided an easy source of marks. Most were able to interpret the experimental data to derive correct orders and a rate equation. Some did not make clear which experiments had provided the data. Most were able to rearrange their rate equation and to obtain the correct value for the rate constant of 0.0128. The units were sometimes omitted but if shown were usually correct.

(a)(ii) Most good candidates collected both marks, starting with the stoichiometry from the rate equation and obtaining two steps which gave the overall equation when added together. Weaker candidates struggled, often starting from the ratios in the overall equation and producing unbalanced steps.

(b)(i) This was generally very well answered, the only common omission being a comparison of moles, rather than moles of gas.

(b)(ii) Most candidates obtained the correct answer of -148 kJ mol^{-1} . Mistakes were sometimes made by use of $25 \text{ }^\circ\text{C}$, rather than 298 K, and -168 , rather than $-0.168 \text{ kJ K}^{-1} \text{ mol}^{-1}$.

(b)(iii) A first mark was available for many candidates for relating an increase in the value of ΔG to a decrease in feasibility. Far fewer were awarded the second mark for identifying that $T\Delta S$ becomes more negative as temperature increases. As with question **1(c)**, candidates confused a more negative value of $T\Delta S$ with a bigger value. Many candidates find it extremely difficult to compare negative numbers and candidates are well advised to use phrases such as '*...more negative...*' and '*...less negative...*' rather than '*...greater...*' and '*...less...*'.

Question 5

(a) Most candidates gave the standard definition for a transition metal in terms of having an ion with an unfilled d sub-shell or d-orbital. The commonest error, made by weaker candidates, was to omit 'ion' or to refer to a 'd-shell'. The electron configurations were usually correct, although some omitted Fe altogether, showed Fe^{2+} as $4s^1 3d^5$ or used capital letters, subscripts or [Ar].

(b) This part discriminated extremely well and required responses that had been learnt thoroughly and expressed precisely. Common errors often resulted from imprecision, including missing charges and incorrect species.

For precipitation, most showed a correct equation and observation. It was less common to see a soluble alkaline reagent such as NaOH.

The commonest responses for ligand substitution involved substitution with ammonia or chloride ions.

With ammonia, many showed the correct complex although water and ammonia were often shown in incorrect ratios or the complex was uncharged. It was also common to see the incorrect complex ion $[\text{Cu}(\text{NH}_3)_6]^{2+}$. With chloride ions, the commonest mistakes were missing charges or use of chlorine instead of chloride. A few candidates used Fe^{2+} in their response instead of Cu^{2+} and could be awarded no marks.

(c)(i) Good candidates easily secured both marks. Weaker candidates often made basic errors with incorrect oxidation numbers or incorrect species being oxidised or reduced.

(c)(ii) Few candidates scored both available marks for a correctly balanced equation. Some managed to produce an unbalanced equation with correct species. Many candidates attempted a balanced equation with H_2 or H^+ as the extra product in place of H_2O and such responses were not credited. When balancing redox equations compounds, H_2O is a common product and it is unlikely that H_2 will be released.

(d) Many candidates showed correct octahedral structures with a correct bond angle. The correct charge proved to be more difficult with many showing 4– instead of 2–. Although the question asked for the hexachloroplatinate ion, the commonest mistake was to include ammonium ions in the structure of the complex.

(e)(i) The bidentate ligand definition was well known but sometimes donation **to a metal ion** had been omitted.

(e)(ii) This part discriminated very well. Many candidates scored one out of the available two marks for either the diamine or the dicarboxylate ion. Many then got confused, either showing the dicarboxylate ion with no charges or the diamine with two negative charges.

Question 6

(a)(i) Most candidates were awarded a mark for a correct circuit, mistakes being commonest for the half-cells. Common errors included the omission of concentrations, an iron, rather than platinum electrode, or a hydrogen electrode.

(a)(ii) Most candidates produced a correctly balanced ionic equation with only a minority obtaining an unbalanced equation.

(a)(iii) This part was answered correctly by nearly all candidates.

(b) Few candidates responded with **both** dichromate(VI) **and** H⁺/acid.

(c) Few candidates chose the correct redox system involving oxidation of HCOOH. Instead, most selected the system involving oxidation of HCHO and no marks were then possible. Even when the correct redox systems had been chosen and combined, electrons and H⁺ ions still had to be cancelled for all marks. Only the best candidates secured both marks.

(d)(i) This question differentiated well with some very good answers but also some very weak responses that just repeated the question. Some candidates started with the E^\ominus value of +1.33 V involving acidified dichromate(VI) ions rather than chromium(III) ions and produced an answer that was the opposite to what it should have been. Many candidates stated that chromium had a more negative electrode potential but there was much confusion over whether Cr was then acting as an oxidising or reducing agent.

(d)(ii) Only the very best candidates recognised that the chromium reacts with acid/H⁺ to produce H₂. The commonest response was simply to suggest that the gas is hydrogen gas.

(e)(i) In contrast to **6(a)(iii)**, few candidates obtained the correct cell potential, the commonest error being 1.17 V from the oxidation of HCHO, rather than that of HCOOH [as in **6(c)**]. Only the best candidates chose the correct redox systems to arrive at the cell voltage of 1.45 V

(e)(ii) The majority of candidates commented that methanoic acid was easier to store as it is a liquid. Other acceptable advantages were seen more rarely.

Question 7

(a) Good candidates added the correct numbers of electrons to the correct sides of each half-equation. Many however, had problems and a variety of numbers of electrons was seen. The correct answers could easily have been deduced by ensuring that the charges were the same on each side of the half-equation

(b) This part proved to be too difficult for many but the very best candidates understood that the acidic nature of CO₂ in solution would remove OH⁻ ions, resulting in an equilibrium shift to the right. Very many deduced that the equilibrium would move to the left as a response to water being used up whilst others produced responses in terms of different moles on either side of the equilibrium. This part discriminated very well at the top end of the ability range.

(c) This calculation was tackled well by most candidates with little over-rounding of intermediate values. The correct answer of 91.8% was seen on many occasions. The first two marking points for the moles of MnO₄⁻ and SO₃²⁻ were those most commonly scored. Many omitted the four times scaling stage to produce a percentage purity of 22.9%.

It was also common to see the incorrect use of the molar mass for the SO₃²⁻ ion (80.1 g mol⁻¹) rather than for Na₂SO₃ (126.1 g mol⁻¹), resulting in a percentage purity of 53.8%.

F326 Practical Skills in Chemistry 2

General comments

The number of centres submitting coursework for A2 continues to grow and the standard achieved by the large majority of candidates was high.

In the samples of work seen by the Moderators, it was evident that each Task was equally represented and the range of marks obtained by candidates was equivalent. The majority of centres are doing more than one Task in each category although it appeared that the use of only one Quantitative Task was not unusual.

It is important that an incorrect answer negates a mark awarded for a correct response. For example, a candidate who has been asked if a particular set of points lies on a straight line and responds that they do although there might be a slight curve has not clearly answered the question asked and cannot be given a mark.

Centres should be careful to check the addition of marks on candidates' scripts. Although relatively few mistakes were detected in the overall addition of the three component marks there were a considerable number of mistakes made when totalling the mark within a Task. It is essential that careful checking is carried out so that the marks submitted are an accurate reflection of a candidate's ability. In a number of centres the marks had been checked by a second member of staff and this is good practice.

Administration

Also see the comments included in the Administration section of the F323 (*Practical Skills in Chemistry 1*) report.

It was unusual for centres to forget to include the Centre Authentication Form (CCS160) with their candidates' work but is an essential form to include with the package sent to the Moderator. A few centres are still including a signed statement from each candidate but this is not a requirement.

Centres are also reminded that it is their responsibility to decide which is the best Task in each category. The main confusion seemed to be cases where a candidate had achieved the same mark for two Tasks in the same category and the teacher did not want to make the decision as to which would be the best to include in the moderation sample. It must be emphasised that the Moderator will not look through the work and decide which to moderate. The work will be returned to the centre for the decision to be made by the teacher.

Chemistry Departments are reminded to take advantage of the e-mail alert service which will notify you of any change that is made to the Chemistry A pages on Interchange. You can register at GCEScienceTasks@ocr.org.uk including your centre number, centre name and a contact name. The subject line should be 'GCE Chemistry A'.

Qualitative Tasks

The quality of the work received was good. Mark schemes indicate the acceptable colours and physical states. Unfortunately some centres awarded marks for observations that were not listed in the mark scheme, e.g. '...goes green...' is insufficient as an observation for a precipitate with no reference to the physical state.

Where multiple observations are required for one mark, no mark should be awarded if any of the relevant observations are absent.

Centres must trial all of the Tasks carefully and check that the centre results agree with the mark schemes before allowing candidates to attempt a Task. Tasks have been trialled extensively prior to publication and it is unlikely that the results provided cannot be obtained. However, in exceptional circumstances the advice below should be followed.

If teachers are unable to obtain all of the marking points themselves with their trial results (having checked the solutions have been made up correctly), their observations should be submitted by e-mail to OCR for advice at GCEScienceTasks@ocr.org.uk.

Quantitative Tasks

Centres are reminded that the sample provided should include Centre results obtained by the teacher and/or a technician. For centres with more than one teaching group, it is essential that it is clear which centre results have been used to assess the accuracy marks for each candidate.

There were two issues over which Moderators expressed some concern. The first was the accurate plotting of points on a graph. It seemed that in some cases centres did not check that this had been done correctly. It is recognised that this is a rather tedious task made more awkward by candidates choosing unexpected scales on the axes but if it is a marking point then it must be done. The second issue was the failure of candidates and markers to notice where it had been specified on the Task that an answer should be to a whole number or a particular number of decimal places or significant figures. This also applies to data such as volumes and times.

The use of the look-up tables supplied with the Quantitative Tasks makes checking the steps in a calculation easier but it is still necessary to look closely if an intermediate mark is available. There were a few cases where a final answer was correct but a candidate had made two errors in a calculation which had cancelled out – the intermediate mark should not then have been allowed.

Care has been taken to provide mark schemes that are flexible enough to cope with calculations that have been done in an expected manner but it may be necessary to read candidates' work to check if an alternative is valid. If a question requires a calculation to prove that a given answer is correct it can be easy to miss that the steps provided by a candidate have not in fact led to the conclusion required.

Evaluative Tasks

Candidates coped with these Tasks well.

Candidates found it difficult to make a prediction followed by a justification. It is important that the answer given relates directly to the prediction made in order to gain credit.

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