

Chemistry A

Advanced GCE A2 H434

Advanced Subsidiary GCE AS H034

OCR Report to Centres

June 2013

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.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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

Entries this session continue to rise across all assessment units and the majority of candidates have been well-prepared for the examination papers.

Nationally the sciences have seen an increased entry in recent years and it is pleasing that more of our young people are seeing the benefits of taking an A level qualification in Chemistry.

Written papers

For F321, the entry showed a very large increase from June 2012, perhaps reflecting that there will be no opportunity to resit the unit in January 2014 (for further details, see A level reform below). The standard of responses involving chemical calculations continues to improve but questions requiring the recall of ionic formulae and the ability to write chemical equations containing realistic formulae is of concern.

For F322, most candidates were taking this unit for the first time. Candidates used the different types of formulae encountered in Organic Chemistry with confidence and there seems to be an increased use of skeletal formulae. When completing reaction mechanisms, careless errors were common as was the imprecise positioning of curly arrows.

Entries for the A2 units F324 and F325 both increased significantly from June 2012.

A common theme across both AS and A2 units is that candidates are much more comfortable when tackling 'stock' knowledge and understanding questions than when answering unfamiliar questions requiring application. The A2 units allow specification content to be assessed in both familiar and unfamiliar contexts. For example, a question related to the role of a buffer may be completed in almost Mark Scheme prose on many scripts. But when confronted with specification content and new information presented in an unfamiliar and unstructured context, the same candidates can struggle despite the new information containing deliberate clues linked to the specification. There seems to be a large leap from memorising specification content and Mark Schemes to applying this knowledge to new situations. This suggests that candidates need more practice with problem solving skills in preparing for the A2 units and for tackling an unstructured inorganic or spectral analysis. Notwithstanding this, the understanding displayed by some candidates when attempting difficult 'stretch and challenge' questions on the A2 units has been exceptional.

Practical Tasks

Candidates were well prepared for the Practical Tasks, displaying high levels of skill in observing, recording, analysing and evaluating. Since the start of the course, it has been possible to hold down boundaries at AS but for A2 there has been a steady upwards drift. This June session, for A2, a more challenging set of practical tasks and more realistic marking by centres have allowed the boundaries for F326 to be reduced.

All Tasks have been trialled extensively in centres and it is unlikely that the results provided cannot be obtained. However, if a teacher identifies problems when trialling or when marking the Tasks, OCR operates a Task Query support system. Advice is available by emailing details of a problem to GCEScienceTasks@ocr.org.uk.

An e-mail alerts service is also available. To be notified by e-mail when changes are made to GCE Chemistry A pages on Interchange, please e-mail GCEScienceTasks@ocr.org.uk including your centre number, centre name, a contact name and the subject line GCE Chemistry A. It is strongly recommended that all centres register for this service.

Continuing Professional Development

This summer, OCR launched an A Level Chemistry conference at The Royal Institution. Sessions were given from a wide range of chemistry experts, and the day provided delegates with new ideas for practical work and ideas to enhance teaching of A Level Chemistry. Feedback from the sessions has been very positive, and OCR hopes to run a similar conference again in the future.

OCR also continues to provide feedback and training for teachers with materials available as part of the Professional Development Programme. For more information, see <https://www.ocronlinetraining.org.uk/>. Further feedback from June 2013 examinations series, and on the coursework units, will be available from this site in due course.

A level reform

In Autumn 2012, Ofqual announced that there would be no January A level examination session from 2014. AS and A2 examinations would be available only in the summer examination period. In the current specification, it will only be possible to resit an AS unit at the end of a two-year A level course. For the A2 level units, there will no opportunity for candidates to resit without entering a third year.

This marks a significant change in entry policy for centres. This arrangement is scheduled to run for the duration of the current specification.

Starting in September 2015, entirely new AS and A level specifications are scheduled to start. Centres will receive further information over the next two years.

September 2015 promises to be a significant month for exam reform of both A level and GCSE qualifications, with concurrent changes taking place for the National Curriculum. Further details of the timeline for examination reform are available from the OfQual website: <http://ofqual.gov.uk>.

GCSE and GCE/A level Science development, tell us your thoughts...

OCR is currently in the process of re-developing GCSE and GCE Science specifications for first teaching from September 2015. To assist with this work we would welcome your feedback regarding anything you would like to see changed or included as part of the new qualifications. If you have any comments/questions regarding GCSE or GCE Science developments please e-mail ScienceDevelopment@ocr.org.uk or join the OCR Community (www.social.ocr.org.uk) to be kept updated.

In summary,

GCSEs are being re-developed for first teaching from September 2015.

- The courses will be linear with separate Science (Biology, Chemistry and Physics) and a Double Award Science;
- There is no Single Award Science as part of the DfE Programme for Reformed GCSEs in Science.

For more details see <http://www.ocr.org.uk/ocr-for/teachers/newsletters/agenda/>, <http://www.education.gov.uk/schools/teachingandlearning/qualifications/gcse/a00221366/gcse-reform> and <http://ofqual.gov.uk/news/ofqual-launches-consultation-on-gcse-reform/>

GCE/A levels for Biology, Chemistry and Physics are also being revised for first teaching from September 2015. (Other Sciences will be developed in a later phase.)

- AS is to be a standalone qualification that does not count towards the A level, covering half the content of an A level and delivered over one or two years;
- The AS could be designed to be co-teachable;
- The standard of the AS is to remain broadly as it is now;
- A level is to be a fully linear, fully synoptic, two year course.

For more details see www.ofqual.gov.uk/news/ofqual-publishes-a-level-reform-correspondence/

Developers

During September, OCR will be advertising for Developers to assist with the drafting of new qualifications for Science. It is expected that adverts will be posted to the OCR website and TES and a notification will be posted on www.social.ocr.org.uk. Alternatively if you register your interest *via* e-mail to ScienceDevelopment@ocr.org.uk, we can send you more details when Developer roles are advertised.

F321 Atoms, Bonds and Groups

General Comments

Once again, the number of entries increased and this session was marginally short of 27,000 candidates. The responses seen suggested that the majority of candidates had been well-prepared for the paper and candidates were able to attempt all the questions.

Questions such as explaining the trend in reactivity on descending a Group, which once were often poorly answered, are now very well handled. The underlying concern is, of course, that these improved answers rely more on recall than they do on greater understanding. This concern is exemplified by answers to questions such as 5(a)(ii) and 5(b)– here standard material was being examined in a rather different way than is usual on this paper and candidates did not perform so well. On a more positive note, the standard of answers involving chemical calculations continues to improve and this paper was no exception with excellent answers to 2(a)(iv), 3(a)(ii) and 3(c)(ii) and 3(c)(iii). It was concerning that many candidates were unable to work out or recall the formulae for ions and consequentially to write and balance related chemical equations. Even fewer could write an ionic equation.

Comments on Individual Questions

Question 1

1(a)(i) For virtually every candidate, this part provided an excellent start to the exam with straightforward marks. There was almost no example of this definition being muddled with that for relative atomic mass which leads to answers referring to the average mass of the isotopes of an element.

Of the few that dropped marks, omission of $1/12^{\text{th}}$ was the commonest error. Other errors included omission of carbon-12 or use of atom/mole. Candidates who failed to achieve any marks often discussed protons, neutrons and isotopes.

1(a)(ii) The values for ^{39}K were correct for all but the weakest candidates. However, the following mark, for the correct values for the ion, was scored much less often, the most common error being to omit the positive charge. Many gave the incorrect response in terms of ^{40}Ar although other combinations were seen. This suggested the question had not been read clearly.

1(b) The majority of candidates gave the correct response. The commonest mistake was to give $3p^4$ instead of $3p^2$. A few gave the electron configuration based on 28. Other errors included writing the d sub-shell instead of p sub-shell.

1(c)(i) In terms of the three stages to this calculation, a large majority gained the first and second marks for working out the correct molar mass and using this to calculate the amount of silicon tetrachloride. Problems came in converting this value into the number of molecules. Some seemed to forget this step altogether or confused this with working out gas volumes. Some candidates used their own value for the Avogadro constant rather than the value given on the *Data Sheet*.

1(c)(ii) Many candidates obtained 1 mark for the arrangement of K and Cl in the lattice but far fewer scored the second mark for the ionic charges. Other non-scoring responses included the use of one type of particle only, usually atoms or ions of potassium.

Question 2

2(a)(i) Although there were many correct responses, a surprising number were unable to identify the ions. There was a surprisingly large number of candidates who gave Al_2^{3+} as the cation. Some gave Al as the anion, showing a lack of basic chemical literacy.

2(a)(ii) This proved to be a relatively challenging question. Weaker candidates did not apply the simple rule of 'acid + base gives salt + water', often giving oxygen or hydrogen as an additional product or not completing or balancing the equation. Others either did not add state symbols or gave state symbols which were incorrect – generally $Al_2O_3(aq)$. This was despite this information being supplied. $H_2O(g)$ and $H_2SO_4(l)$ were also frequent errors.

2(a)(iii) This part was generally answered well. The easiest route to the answer was simply to associate xH_2O with the waters of crystallisation. Candidates also gained the mark by successfully explaining that xH_2O represented the number of molecules of water in each formula unit of the hydrated salt but this more often led to answers that fell short of the mark.

2(a)(iv) Answers to this question were relatively impressive. Where errors did occur they often arose from confusion between using the mass of the hydrated salt and the anhydrous salt as a basis for determining the number of moles of $Al_2(SO_4)_3$ present. A few candidates gained both of the first two marks but then could not see how to translate these into the correct value for x , perhaps because the value is one they may not have met previously.

2(b)(i) This was not answered as well as expected. In some cases the proposed equations were chemically incorrect in terms of the products proposed and so indicated a lack of understanding of basic redox principles. The subsequent explanation for the blue litmus paper turning red often did not link with the products of the reaction, often simply stating that acids turn blue litmus red. Some of the weaker candidates produced incorrect products in the equation, such as OH^- ions, claiming that these ions were responsible for litmus turning red.

2(b)(ii) Very few answered this part correctly. A surprising number didn't make the connection even having stated $HClO$ in the equation or gave a compound, usually $NaClO$, instead of the required ion. A surprisingly large number of candidates thought that Na^+ ions were responsible for bleaching.

Question 3

3(a)(i) This part was usually well answered. When oxidation numbers were assigned incorrectly these errors usually suggested that P was +3 in PH_3 or gave an incorrect oxidation number for P in NaH_2PO_2 . Almost every candidate identified that this example of disproportionation involved the oxidation number of phosphorus both increasing and decreasing. On some occasions, candidates did not state which changes in oxidation number were associated with oxidation and reduction.

3(a)(ii) This calculation was well answered with most candidates gaining both marks. A few candidates confused phosphorus with phosphine and a very few candidates multiplied by 24 rather than 24000 – these errors were rare.

3(b) This part was well answered although a few candidates confused P_4 with PH_3 and so were forced to add hydrogen as a reagent to generate the water product.

3(c)(i) Many candidates were able to recall the definition of a salt and apply it to this example. It is important that candidates refer to sodium **ions** or hydrogen **ions** rather than atoms. Responses based upon the idea that a salt was simply the product of the reaction between an acid and a base received no credit.

3(c)(ii) Most candidates were able to complete this straightforward calculation.

3(c)(iii) This response was probably the least well attempted of the calculation questions. Although many candidates recognised the mole ratio, they often forgot to multiply by 1000 or they divided by concentration. Some carried out various additional non-relevant calculations.

3(d)(i) This proved to be a contender for the most challenging question on the paper. Whereas many candidates were able to identify hydrogen bonding as being the major intermolecular force in NH_3 , very few realised that PH_3 molecules have a permanent dipole. Some weaker candidates thought that the breaking of chemical bonds, usually covalent, was the reason for the difference in boiling points.

3(d)(ii) This part was well answered and most candidates were able to make the correct link between boiling point and the strength of the intermolecular force, even if these answers referred to the wrong force between the PH_3 molecules. Candidates are encouraged to think about their answers. For example, ' NH_3 has stronger van der Waals' forces than PH_3 ' is clearly incorrect as PH_3 has far more electrons than NH_3 .

3e(i) Nearly all candidates were able to correctly recall this definition. The only recurring error involved candidates referring to elements or molecules rather than atoms for the source of the shared pair.

3(e)(ii) This question was designed to be challenging and it proved to be so. Through a poor choice of dots or crosses, many candidates failed to show unambiguously whether the electron pair in the N–B bond had been donated by N or B. Many candidates did not show full outer shells on the F atoms and sometimes the dative covalent bond was shown for one of the N–H bonds.

3(e)(iii) The bond angle in BF_3 was well known but the bond angle in H_3NBF_3 was answered correctly less often with 107° being seen often. Weaker candidates often chose 90° , presumably as a result of seeing the structural diagram of H_3NBF_3 .

3(e)(iv) The mark for stating that a lone pair of electrons repels more than a bonding pair was almost always awarded. Candidates did not always state the numbers of bonding and lone pairs around the central atom in both ammonia and H_3NBF_3 . Candidates are advised that correct wording is essential and phrases such as 'lone pairs repel more than electron pairs' will not receive credit.

Question 4

4(a) The responses to this type of question continue to improve. Although the context of the reaction of the metals with chlorine led a few candidates to discuss the reactivity of the Group 7 elements, this was extremely rare and more often full marks were awarded for this part. As ever, candidates are advised to use bullet points to help reduce repetition of some points and omission of others.

4(b) This part was not strongly answered. Many ignored the requirement for a precipitation reaction in the stem of the question, instead choosing a displacement reaction. Consequently some good chemistry went unrewarded.

4(b)(i) Silver nitrate was known by many as the correct reagent. Candidates are advised that vague responses such as 'silver ions' are unlikely to be credited.

4(b)(ii) 'Yellow precipitate' was commonly seen. Candidates are advised not to use terms such as 'creamy–yellow' which could also suggest that bromide ions were present.

4(b)(iii) This question differentiated well.

4(b)(iv) Only relatively few candidates realised that the ammonia had to be **concentrated**.

Question 5

5(a)(i) Candidates found this explanation more challenging than the trend in reactivity down a Group in 4(a). Nevertheless it was not uncommon here also to award full marks. Some candidates did contradict a correct statement that shielding stayed the same with an incorrect comment that the radius also remained unchanged.

5(a)(ii) This question applied knowledge and understanding of ionisation energy and many candidates did not realise that it is individual gaseous atoms that lose an electron and thus the gaseous atoms are identical whether they come from diamond or from graphite.

5(b) This part revealed much about the candidates' ability to apply their knowledge and understanding. Although many scored well it was a little surprising that many were unable to identify the forces acting between fluorine molecules or the names of the particles present in structures of carbon or fluorine.

F322 Chains, Energy and Resources

General Comments

The average mark for this examination paper was 62 and candidates scored marks covering the whole mark range. Most candidates attempted the longer questions and there was some improvement in terms of organisation of these answers compared to previous sessions.

As in previous sessions there was clear evidence that candidates had used the Mark Schemes from previous examinations to inform their revision.

Although some of the longer questions were at the end of the examination paper there was no evidence from the scripts that candidates did not have enough time to finish the examination.

Candidates were able to use the different types of formulae with confidence and there seems to be an increased use of skeletal formulae. However, candidates need to be careful that they give the type of formula asked for in the question.

Candidates often made careless errors when completing reaction mechanisms using the 'curly arrow' model. Candidates need to make certain that the arrow starts from a bond, a lone pair or the negative sign of an ion.

There has been an improvement in the candidates' ability to organise their answers to quantitative questions; however this improvement needs to be continued in future sessions so that any error carried forward can be clearly seen and given credit.

Centres also need to advise candidates to cross out all answers they do not want the examiner to consider to avoid answers having contradictions.

Comments on Individual Questions

Question 1

This was the most accessible question and allowed candidates to gain confidence for the rest of the examination paper.

1(a)(i) Most candidates were able to state the molecular formula for decane.

1(a)(ii) Many candidates were able to draw a skeletal for a branched chain isomer of $C_{10}H_{22}$; however candidates were less likely to be able to name the isomer. Common errors included incorrect position numbers or not recognising the longest carbon chain, for example giving the name 2-ethyloctane rather than 2-methylnonane.

1(a)(iii) Most candidates recognised that the boiling point was related to the number and strength of the van der Waals' forces between hydrocarbon molecules. Not all candidates referred to the smaller surface contact with the branched isomers. Some candidates did not take the answer further and refer to the energy needed to overcome the van der Waals' forces. Weaker candidates often referred to the presence of weaker bonds rather than weaker intermolecular forces.

1(b)(i) Most candidates were able to write an equation for cracking.

1(b)(ii) Candidates were often not sufficiently precise with their answer, referring to any bond being able to break within the hydrocarbon or that the chain could be cracked anywhere within the hydrocarbon molecule. The Mark Scheme required specific reference to breaking carbon-carbon bonds within the hydrocarbon molecule.

1(c)(i) Candidates found this part very straightforward and were able to draw a correct structure. The most common answer was cyclooctane and only a very small number of candidates drew aromatic substances or those with six membered rings. Candidates need to be careful when working out the answers to such questions so that they do not leave contradictory structures in the answer space.

1(c)(ii) The importance of cycloalkanes to the petroleum industry was well known.

Question 2

2(a)(i) Most candidates were able to recognise **H** and **E** as structural isomers.

2(a)(ii) Most candidates were able to recognise **H** as a tertiary alcohol.

2(a)(iii) Many candidates recognised **F** as an alcohol that can be oxidised to form a carboxylic acid. **E** and **G** were common incorrect answers.

2(b)(i) Many candidates were able to give the molecular formula for **G** as $C_5H_{10}O$, although a significant proportion of candidates showed the OH group in their formula.

2(b)(ii) Although many candidates could name alcohol **C**, other candidates made careless mistakes either in position number or missing out letters from the name, e.g. 2-methpentan-3-ol or 2-methylpent-3-ol.

2(c) The Mark Scheme required the definition given in the specification. Candidates needed to specify the same functional group and that each successive member varies by a CH_2 group. Some answers were imprecise and referred to the same molecular formula or just that members vary by a CH_2 group.

2(d) Candidates found this part quite difficult and a small proportion of the candidates left the question blank. Some candidates were not able to relate the reactions of alcohols to the cyclic alcohol in the question. Some candidates ended up with straight chain structures rather than cyclic. Candidates often found the oxidation reaction the easiest of the three reactions described but a common misconception was to end up with a 'carboxylic acid' but having five bonds around a carbon atom. Candidates found the elimination reactions the most demanding and the two structures required were often left blank. Other candidates drew the same structure twice or had one of the structures as water.

Question 3

3(a) A significant proportion of candidates were not able to recognise the ester functional group with ketone and aldehyde being common incorrect answers. Most candidates recognised the carbon-carbon double bond. Candidates had to be careful to name these functional groups since representations such as $C=C$ were not accepted in the Mark Scheme.

3(b) Candidates often recognised the importance of the carbon-carbon double bond but a common error was just to refer to a double bond.

3(c) The colour change was well known but a number of candidates gave the orange to green colour change for acidified potassium dichromate instead of bromine.

3(d)(i) The Mark Scheme required a generalised definition rather than a definition based on *E/Z* isomerism. A small proportion of candidates referred to the same molecular formula rather than the same structural formula. Other candidates failed to state the same structural formula and just focused on a different arrangement in space.

3(d)(ii) The best answers gave a diagram rather than using words to describe the difference. Some candidates contradicted themselves by drawing the *E*-isomer but referring to it as the *Z*-isomer.

3(e)(i) Many candidates could give a correct definition; however some candidates neglected to state the amount of substance or that it had to be complete combustion.

3(e)(ii)–(iv) Candidates found the calculations in these parts straightforward and often scored either maximum or near maximum marks. Often candidates forgot to include the negative sign in the final enthalpy change. A common error in (ii) was to use the mass of the fuel or the mass of the fuel and water in the $mc\Delta T$ expression. Other candidates did not convert to kJ at this stage.

3(e)(v) Many candidates recognised that incomplete combustion occurred but did not explain why black smoke was obtained in terms of the formation of carbon.

3(f) The equation for the fermentation of glucose was well-known as were the conditions needed for fermentation. Candidates often gave more conditions than were needed to be awarded full marks. The most common conditions given were the use of anaerobic conditions and a correct temperature. A small proportion of candidates confused fermentation with hydration and as a result gave the conditions for hydration of ethene.

Question 4

4(a)(i) Although the mechanism was often recognised as electrophilic addition, some candidates made significant errors in terms of the direction and positioning of curly arrows. Candidates need to ensure that curly arrows start from a bond, a lone pair or the negative charge of a nucleophile. Some candidates drew the carbonium ion with a partial positive charge rather than a full positive charge.

4(a)(ii) Electrophilic addition was recognised by most candidates.

4(a)(iii) The other product of the reaction of IBr with propene was well known although a small proportion of candidates gave the 1,1 product rather than the 1,2 product.

4(b)(i) Many candidates could suggest the conditions for the reaction of IBr with methane, although a common incorrect answer involved the use of an acid catalyst.

4(b)(ii) The best answers were well organised with the name of the reaction and the type of fission along with four equations (one initiation, two propagation and one termination). These candidates selected the propagation steps and termination steps that gave the products mentioned in the stem of the question. It was this good organisation of their answer that was rewarded with a mark for the quality of written communication. Other candidates included many more equations and often contradicted earlier correct equations. A common misconception was to have hydrogen radicals being formed and reacting in the propagation and termination steps. Another misconception was to have propagation steps that involved either iodine molecules or bromine molecules. Weaker candidates often gave equations involving heterolytic fission and had negative and positive particles in all of their equations.

Question 5

5(a) Despite a complicated equation, candidates were often able to complete the calculation successfully getting the answer $-4596 \text{ kJ mol}^{-1}$. The most common errors were often mathematical rather than chemical although some candidates did get the cycle the wrong way round and calculated $+4596 \text{ kJ mol}^{-1}$. There was an improvement in the organisation of the candidates' answers so that examiners were able to identify marking points for awarding marks by error carried forward.

5(b)(i) Many candidates realised that the question referred to 10 moles of N_2O ; however they were not able to use the stoichiometry of the equation to realise that the enthalpy change was +820 kJ rather than +1640 kJ.

5(b)(ii) Many candidates incorrectly gave the answer $+164 \text{ kJ mol}^{-1}$ rather than the correct $+82 \text{ kJ mol}^{-1}$.

5(b)(iii) Some candidates were able to interpret the energy profile diagram to calculate the reverse activation energy to give the answer of $+283 \text{ kJ mol}^{-1}$. Common errors included adding the two values in the table to get $+611 \text{ kJ mol}^{-1}$ or quoting a negative value because it was the reverse reaction.

5(c) Candidates often referred to ozone depletion rather than how the concentration of ozone remains fairly constant. As a result, a common incorrect answer was $\text{O}_3 + \text{O} \rightarrow 2\text{O}_2$. The best answers gave the two equations $\text{O}_3 \rightarrow \text{O}_2 + \text{O}$ and $\text{O}_2 + \text{O} \rightarrow \text{O}_3$ and then went on to comment that the rates of these two reactions were equal.

5(d) Many candidates gave the two required equations involving NO catalysing the breakdown of an ozone molecule. A common error was to give two equations that involved the formation of a nitrogen radical and its subsequent reaction with ozone.

Question 6

Many candidates could interpret the mass spectrum.

6(a)(i) Most candidates recognised 256 as the m/z value for the molecular ion.

6(a)(ii) Most candidates deduced that the molecule was S_8 . A small number of candidates gave the formula as S_4 or S_2 .

6(a)(iii) Candidates often gave S_4^+ but a significant proportion did not include the positive charge.

6(b) Candidates were familiar with the type of calculation and many obtained the correct answer of 195.2 with only a small proportion of candidates quoting more than one decimal place.

6(c) The most common response was use as a breathalyser, although other candidates gave monitoring air pollution.

6(d) Some candidates gave a very good answer, fully explaining how they deduced the two possible structures of the solvent **L**. Many candidates used the percentage data and relative molecular mass to calculate the molecular formula as $\text{C}_4\text{H}_8\text{O}$. Candidates found the interpretation of the infrared spectrum much more difficult. Some candidates stated that **L** was a carboxylic acid even though the spectrum did not have the appropriate O–H absorbance. Candidates would be advised to focus on the characteristic absorbances that occur above 1600 cm^{-1} rather than focusing on the fingerprint region of the spectrum. Other candidates suggested that the structure was an ester but did not rule this out because the molecular formula showed that only one oxygen atom was present. Most candidates drew displayed formula for their suggested structures.

Question 7

This was the most challenging question in the examination paper.

7(a) Many candidates chose the CFC, **N**, but other candidates chose the chloroalkane, **R**.

7(b)(i) Many candidates appreciated that **S** would hydrolyse to give a diol.

7(b)(ii) Although many candidates appreciated that the reaction was an example of nucleophilic substitution they did not always draw a perfect mechanism. Some candidates used KOH as the nucleophile and did not appreciate that the nucleophile was the hydroxide ion. Other candidates were not sufficiently careful about where the curly arrows started from. The last marking point for the mechanism required the candidates to give the products of the reaction and common errors involved giving KBr rather than the bromide ion or writing $C_3H_7CH_2OH$ as the alcohol which is an ambiguous structure. The Mark Scheme required $CH_3CH_2CH_2CH_2OH$. Only a very small proportion of the candidates drew a S_N1 mechanism and this was given full credit in the Mark Scheme.

7(b)(iii) The Mark Scheme required candidates to compare the bond enthalpy, bond strength or bond length of the C–I with the C–Br bond and then link this to the ease of breaking the bond. Some candidates did not specify the bonds and others just compared the reactivity of iodine and bromine.

7(c) Candidates found this part very challenging and even if they chose the correct halogenoalkane, they did not write an equation with structural formulae as required in the stem of the question. Many candidates chose reactions involving Br_2 or HBr to make **P**.

7(d) The most common answer was HFCs but some candidates gave specific compounds which were not allowed on the Mark Scheme since a type of compound was needed.

Question 8

8(a) Many candidates could draw two repeat units and only a small proportion of candidates did not draw the continuation bonds.

8(b) Candidates had little difficulty explaining why the reaction had a 100% atom economy in terms of making only one product.

8(c) Although many candidates understood le Chatelier's principle and could predict how the position of equilibrium would shift, candidates found it much more difficult to explain why the position of equilibrium shifted. Candidates did not clearly explain which reaction was exothermic or which side of the reaction had the most molecules. Some candidates quoted le Chatelier's principle rather than applying it to the changes in conditions described in the question. Many candidates appreciated that the removal of a catalyst has no effect on the position of equilibrium.

8(d) Many candidates could calculate the percentage yield as 95.5%. Candidates used two different approaches, one using moles and the other using mass. The most common errors came from not converting from kilograms to grams correctly and hence getting an incorrect amount in moles, or by calculating the wrong relative molecular mass.

8(e) Candidates often drew just one graph showing the effect of both an increased temperature and the addition of a catalyst. However a significant proportion of candidates did not draw completely correct Boltzmann distribution curves, often not starting at the origin or ending up at 0 on the x-axis. Other candidates neglected to label the two different temperature curves and so could not be credited with this marking point. The labels for the axes were well known although some candidates labelled the x-axis as time or progress of reaction. In terms of the written answers, some candidates did not describe the effect of increasing the temperature or adding a catalyst and focused on the explanation instead. Good explanations referred to more successful collisions per second and more particles with energy above that of the activation energy.

F323 Practical Skills in Chemistry 1 (Coursework)

General Comments

This year in excess of 35,000 candidates were entered for this unit from over 1,100 centres, representing another significant increase both, in centres adopting this scheme of assessment and the number of candidates entered for the subject at this level.

This scheme of assessment is popular with centres mainly due to its ease of operation and the in-built flexibility which allows centres to choose appropriate Practical Tasks to fit in with their teaching schemes. It is clear that centres prepare candidates well for the demands of the Tasks with many centres submitting marks covering the full range of advanced level grades.

In many centres it is clear that there is an excellent understanding of the requirements of the unit and the vast majority of centres submit marks that can be confirmed by the moderation process. Most centres provide accurately marked work with suitable annotation making it clear to the Moderator why a particular mark has been given. The best centres arrange their work by candidate, attach a coursework cover sheet (not a requirement) detailing the marks awarded for each skill, ensure that centre results are provided and complete the required CCS160.

These centres are thanked for the time and effort that goes in to ensuring that the sample submitted to their Moderator can be dealt with quickly 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. Centres should not send more than one Task in each skill area for any one candidate. Some centres have their work returned each year because they do not meet this requirement.
- Centre Results which should have been 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 scheme of assessment regulations.
- Any correspondence from OCR.

Moderation can be delayed by some weeks for centres where clerical or transcription errors are found in the submitted marks. Clerical errors are often found within individual Tasks where marks have not been added up correctly often as a result of marking not being clear. It is suggested that centres should give a tick for each marking point awarded and then the number of ticks on the Task should be equal to the number of marks awarded.

Clerical errors also are found in the adding up of marks for the three Tasks. OCR provides a spread sheet on Interchange which selects the best scoring Task for each Task type and adds these up to give the total for each candidate. This can serve as a suitable checking process especially for centres with large entries.

Finally, centres sometimes transpose marks incorrectly onto Interchange or the MS1. It must be emphasised that it is the centre's responsibility to ensure that the marks submitted reflect accurately the work of their candidates.

Where clerical errors are found in the moderated sample, centres will be contacted to amend their marks. However, not all work requested for moderation is sampled so centres should not rely on moderators to correct centre errors. If a clerical error is notified to a centre it is vital that this is dealt with in a timely fashion.

The most serious issue for moderators is when the marks awarded by the teachers in a centre cannot be justified. If the marking is found to be generous then the centre marks will be adjusted downwards and if found to be harsh an upwards scaling will be applied. This year there are a number of centres whose marks have been adjusted. When this occurs all of the marks in the centre are adjusted not just the candidates sampled by the moderator. Applying a scaling factor however is much more difficult when the marking in the centre is deemed to be inconsistent as this may lead to an unfair outcome for some of the candidates in the centre. In order to produce a fair outcome the centre is required to remark the work.

Where a moderator finds that some work has been marked accurately and some has been marked harshly or leniently the work is returned to the centre as an invalid order of merit. Specific advice will be provided to the centre in order that a reliable rank order is established. Should the centre decide not to remark their work in accordance with the guidance provided a scaling factor will be applied to align the centre marks with the Mark Scheme provided. This process could easily be avoided if centres carefully checked the Mark Schemes and additional guidance before awarding marks and put in place a process of internal moderation to check that all teachers in the centre are applying the Mark Schemes in the same way. Some centres have had work returned this year and in previous years and it is recommended that the teachers in these centres use training material available from the CPD website.

During the year the senior moderation team review all practical Tasks in light of centre comments and feedback. As a result of this process Mark Schemes are reviewed for the next academic year. Occasionally, during the year, a Task or Mark Scheme may be updated to reflect an identified issue or to provide clarity of marking. Although this occurs rarely it is important that centres check Interchange prior to carrying out a Task to ensure the most up to date materials are being used.

Candidate Performance

Candidates continue to perform well in all of the Task areas and in some cases display outstanding skill in observing, recording, analysing and evaluating. Calculations are carried out competently however many candidates fail to give their answers to the specified number of significant figures, decimal places or even to the nearest whole number when required. 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.

It appears from the submissions moderated this year that each one of the Tasks is being used equally by centres although the roll-over Tasks from the previous two years always appear slightly more popular possibly due to them being more familiar to teachers or due to centres having sufficient supplies of the chemicals left over from previous sessions to operate the Task again.

Qualitative Tasks

This year, moderators saw equal numbers of the three Qualitative Tasks. These provided adequate discrimination with the most able candidates being able to access full marks whilst the least able scoring typically three or four marks.

The Qualitative Task still proves to be demanding for candidates who frequently find it difficult 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. Where a marking point requires multiple observations centres must ensure that all observations required are recorded before a mark is awarded.

Some examples of observations given by candidates in this year's sample are given below:

"The magnesium metal appeared murky" does not communicate that the magnesium turns grey or black and this does not gain credit.

"The bottom layer changes colour and there is a purple ring in the test-tube" does not communicate that the upper layer turns purple or violet.

"It turned yellow and a precipitate is formed" does not communicate a yellow precipitate as the colour yellow is not linked to precipitate and this should not gain credit.

Centres must try out 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 in centres 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 any of the marking points themselves having checked the solutions have been made up correctly, their observations should be submitted by e-mail to GCEScienceTasks@ocr.org.uk at OCR for a decision as to whether these alternative responses can be credited.

However, when approval is granted by OCR these observations become the observations by which all candidates in the centre must be judged. These decisions must then be included with the work for Moderation when submitted. If a centre discovers a problem whilst carrying out or after carrying out a Task the only alternative (and the OCR guidance) would be to carry out a different Task.

There were a number of areas where the moderators could not support the centres' judgement and it is essential that the Mark Scheme is carefully followed and any observations that are not included in the Mark Scheme should not be credited.

- 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.
- Where a question asks for the identity of an ion, this can be identified by name or formula but where a name is given, it must be the precise name of the species. For example chlorine cannot be credited if the required name of the ion is chloride.

Quantitative Tasks

The Quantitative marks were slightly higher on the whole than in previous years possibly due to the fact that two of the Tasks were titrations with a similar calculation. It was evident in samples that both titration exercises were frequently carried out in centres with one being used effectively as a practice with the second being used in order to improve marks.

Quantitative Task 1 deals with two areas of the specification those of rates and enthalpy so may have appeared to be more demanding however many candidates obtained high marks on this Task. In Quantitative Task 2, it is important that the centre uses their mass and titre rather than just their titre in order to award the accuracy marks. It is surprising that some centres still do not see the need to do this. Clearly if a candidate uses a different mass to the teacher a different titre should be expected.

The same issues arise each year with this skill area.

- Centres should use the look-up tables provided alongside the Task templates on Interchange to assess candidate's accuracy. Some centres use their own tables which sometimes are more lenient or harsh than the tables provided. It is surprising that some centres claim not to know about these look-up tables.
- 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.
- In all Tasks, it is essential that candidates use the Periodic Table values for relative atomic mass in the Data Sheet to avoid the possibility of being penalised in mole calculations.

Evaluative Tasks

For the Evaluative Task many centres presented Tasks 2 and 3. Task 1 may be seen less than the others as a result of the content and the need to complete spectroscopy and carboxylic acids before embarking on the Task, topics which are frequently taught late in the year. With the removal of the January sitting, and potential changes in teaching order it may be that this Task is used more next year.

It is clear that candidates and centres are more confident with the treatment of error calculations and many excellent examples of error calculations with excellent explanations were seen.

There were a few areas in the marking of the Evaluative Tasks which were of concern to the Moderators. These included:

- Where candidates are asked to produce an equation, this should be balanced and contain the correct state symbols when required in order to gain a mark.
- When dealing with spectra, candidates can only be credited if the ranges and absorbances are related to the correct bonds.
- Where an answer requires an effect and a reason for a mark, it is important that both are present and both are correct before a mark is awarded.
- The only answer that should be credited is that presented on the answer line. If a candidate has a correct answer in the body of the script but then decides to give a different answer on the answer line a mark should not be awarded.

Centres should remember the importance of providing a single and reliable set of marks for the candidates in a centre which reflect the abilities of the candidates entered. Awarding marks which cannot be justified for individual candidates puts all of the candidates' results in jeopardy and inevitably will lead to an adjustment being made.

F324 Rings, Polymers and Analysis

General Comments

The paper was accessible to a wide range of candidates and the marks awarded spanned the whole range from 0 to 60. Candidates had no difficulty in completing the paper in the allotted time and there were very few instances where questions were not attempted. Structures, diagrams and working for calculations were usually clear but a handful of candidates omitted H's from 'sticks' which represent methyl groups in organic structures.

Many candidates used a mixture of displayed and skeletal features in the same structure. One consequence of the mixing of different types of formulae e.g. adding C's to a skeletal chain, was that this often resulted in too few or too many C's in the chain or H's omitted. Candidates would be well advised to use the type of formula provided in the stem of the question.

The use of arrows in mechanisms continues to improve but there are still candidates who start or finish the arrows in the wrong place. Candidates need to ensure that the positive charge in a benzene intermediate is within the broken ring.

Comments on Individual Questions

Question 1

1(a)(i) Many candidates gave glycerol as the systematic name or omitted the 'tri' of triol. Tripropanol was a common incorrect answer.

1(a)(ii) The main reason for not scoring all three marks was by drawing the carboxylic acid rather than the sodium salt. Many candidates showed hexanoic acid twice whilst others showed the structure of glycerol.

1(b) The key to this question was the identification of a *trans* fat and the link to depositing 'bad' cholesterol in arteries. Cholesterol needed to be spelled correctly. This was often not the case.

Question 2

2(a) This part required candidates to link the lone pair on the nitrogen atom to acceptance of a proton. Many candidates did not gain this mark by simply stating 'it is a proton acceptor'.

2(b) The equation for the reduction of 4-aminophenol proved difficult for many who could not balance the [H] needed.

2(c) Many candidates coped well with this unusual mechanism. A common error was to have Br⁻ as the leaving group.

2(d)(i) This part was answered well.

2(d)(ii) This part was answered well.

2(d)(iii) Many candidates could not balance the equation for reaction II. Hydrogen was a common product with only one Br₂ being used.

2(d)(iv) This part was answered well.

2(e)(i) Almost all candidates scored this mark.

2(e)(ii) There were some excellent answers to this question. The conditions for reaction 3 were less well known, alkaline conditions being required. Many simply answered with 'temperature <math><10^{\circ}\text{C}</math>'.

Question 3

3(a)(i) The word 'monomer', required for the mark, was often not used.

3(a)(ii) This was answered well by a majority of candidates.

3(a)(iii) In the specification, the isoelectric point is defined as the pH at which the zwitterion exists and pH was required for this mark. Most candidates could accurately draw the zwitterion of glycine.

3(b)(i) Most candidates gained this mark with just the occasional absorption seen. A small number of candidates gave partition as the answer and this was credited.

3(b)(ii) Most candidates received full marks here.

3(c) Common errors seen in the structure were O's either within the peptide link or as terminal O's adjacent to the C=O group. A number of candidates missed the H off the N of the amide group, which is required in skeletal structures.

3(d)(i) Ethane-1,2-diol was usually drawn correctly. Butenedioic acid was often drawn as the *cis* isomer rather than the required *trans* isomer.

3(d)(ii) This part was rarely correct. The few candidates who did answer correctly tended to use the displayed formula rather than the skeletal formula.

Question 4

4(a)(i) This part proved to be difficult, probably because of the requirement for two correct answers for only one mark. A common error was to change the secondary OH group into a carboxylic acid rather than a ketone.

4(a)(ii) This was a straightforward mark for most candidates.

4(a)(iii) A large number of candidates answered this correctly.

4(a)(iv) Very few candidates described this reaction as nucleophilic addition. Reduction was much more common and was credited.

4(b) This is a well-known reaction and provided two marks for the majority of candidates. A few candidates wrongly opted for Tollens' reagent.

4(c)(i) Many candidates drew the mirror image to obtain this mark, although a number omitted the OH on the lower chiral centre. There were many other ways of showing a correct optical isomer and all were credited. A number of candidates confused optical isomerism with *E/Z* isomerism.

4(c)(ii) A common error was to calculate the M_r of **G** incorrectly. Candidates could still be credited for their final answer provided that the method was correct and that the percentage was expressed to three significant figures.

4(c)(iii) A common error was a six-membered ring, rather than a five-membered ring. Most correctly showed H₂O as the second product.

Question 5

5(a) Most candidates were able to show that the molecular formula of **L** was $C_{10}H_{12}O_2$. Two approaches were common, either via the empirical formula or by using the percentages to calculate the numbers of C, H and O based on the M_r of 164. A few candidates simply took the given formula and added up the sum of C, H and O to arrive at 164. This was not credited.

5(b) This part was almost always correct.

5(c)(i) The use of TMS as a standard was well known, with few candidates confusing TMS with D_2O and its removal of labile protons.

5(c)(ii) The required answer needed candidates to realise that the integration trace provided information about the relative number of protons in a particular environment. Candidates did not seem to realise that this is not necessarily the same as the 'total number of protons in the molecule'.

5(c)(iii) This question asked candidates to use the information given to them in parts (a), (b) and (c) to identify compound **L**, with full reasoning. This usually meant that at least two pieces of information about each structural feature were required. Good candidates managed to answer this part well and some excellent responses were seen. Weaker candidates were less successful often from insufficient and imprecise details. Particular weaknesses included not using the information given by the integration trace to state the number of protons present in a particular environment and not using the ^{13}C data at all. Candidates often listed all possible structures for a particular chemical shift value from the provided *Data Sheet*. It was common to see statements such as 'the peak at 2.7 could be either $HC-C=O$ or $HC-N$ '. As the compound does not contain N, this contradiction meant that recognition of a multiplet $HC-C=O$ could not be credited. To secure good marks, candidates needed to use the spectral information to support a possible organic structure, not simply match and extract information from the *Data Sheet*.

F325 Equilibria, Energy and Elements

General Comments

It was evident that most candidates had made some attempt to prepare for the exam by revising the subject material, but many found it quite difficult to apply what they had learnt to different situations.

The standard of difficulty was appropriate, with most candidates achieving over 40% but only the most able achieving over 80%. There were some stretch and challenge questions for the most able, but a sufficient number of straightforward questions for the weaker candidates to access.

Overall, the standard of performance in this paper was strong but it is important to stress to even the most able candidate that there are areas of preparation that could be improved.

- Firstly it is important to give a full clear and succinct answer and not either to waste time giving superfluous information, as was often the case in 4(d)(i), or at the other extreme insufficient explanation.
- Secondly it is important to be secure in terms of basic chemical skills such as the ability to check that an equation is balanced in terms of the sum of the ion charges of the reactants and that of the products, and to be able to judge the magnitude of an answer from the data given.

Answered well

- 1(a) and (b), 3(a), 4(a), 6(a)(i) and (ii) and 7(c) were answered well. This showed that candidates were able to perform standard calculations relating to lattice enthalpy, equilibrium, straightforward pH concepts, entropy and free energy, and electrode potentials.
- Basic explanations and definitions, e.g. 1(a), 1(c), 4(d)(i) and 7(a) were also answered well.

Common Errors

- Failure to use the information and clues given in the question (5, 7(d) and 8).
- Poor setting out of unstructured calculations (4d(ii), 6(b), 8(c)).
- In Question 5, many candidates showed a lack of understanding of inorganic chemistry and an inability to use the information given in the question.
- Lack of precision in balancing equations and giving charges on ions (4(b) and 5).

There was no evidence that any time constraints had led to a candidate underperforming and scripts where there was no response to the final question also had large sections of the paper which had not been tackled.

Comments on Individual Questions

Question 1

1(a) The majority of candidates got off to a very sound start here and easily picked up these first two marks. When this did not happen, the more common reasons were either that answers referred to a mole of gaseous ions, or that mention of a mole was omitted altogether. Occasionally some weaker candidates confused the definition with that of the enthalpy change of formation and so referred to forming a mole of the ionic compound from its constituent elements.

1(b)(i) Many candidates successfully completed the Born-Haber cycle to obtain both marks. State symbols were almost invariably correct but very occasionally they were missing. Ion charges were usually correct. The commonest error was in the number of electrons with some

showing just one electron instead of two on formation of $\text{Ca}^{2+}(\text{g})$; others showed one or two electrons together with the two gaseous ions.

1(b)(ii) Whereas virtually every candidate displayed some grasp of the material in tackling this question a few did fall down on some key details, the most common of which was to fail to specify that the enthalpy change of atomisation had to refer specifically to oxygen. A few weaker candidates confused electron affinity with ionisation energy or omitted the 'second'.

1(b)(iii) Most candidates correctly calculated the lattice enthalpy as $-3454 \text{ kJ mol}^{-1}$. The sequence of values required to solve the lattice enthalpy was usually correct, the commonest mistakes being when transforming the equation or with transcription errors from the data in the question.

1(c) Although the marks for this question were relatively high, there were many candidates who clearly had a good understanding of this topic but failed to convey this with sufficient clarity to be able to score all three marks. The first key point to stress to candidates is that when comparing the value of lattice energies it is essential to describe one as more exothermic or more negative than another, as terms such as 'greater' or 'larger' are unclear when referring to negative quantities. The second key point is to stress the need to refer to ions and not to refer to atoms. Many candidates wrote at length for this answer when a few lines would have sufficed.

Question 2

2(a)(i) This part was answered well by most candidates. The only problem was the inclusion of the word 'product' rather than 'reactant'.

2(a)(ii) Most candidates knew how to tackle this question but some did not gain the marks because of confusion over the values of the half-lives. It was not uncommon to see candidates refer to the first half-life as 54 s then the second as 102 s and so fail to pick up the first mark, although they then stated that the reaction was first order as the half-lives were the same and so gained the second mark. Candidates need to be clear about the difference between the value of the half-life and the time they are reading from the graph.

2(a)(iii) Despite many identifying in 2(a)(i) that a first order reaction has a constant half-life, many candidates responded here with changing half-lives, usually doubling or halving. Only about half the candidates responded with the expected 'no effect'.

2(b)(i) This part tested several different skills, drawing a tangent at 40 s, calculating the gradient of the tangent, and writing down the units for rate. Most knew the units and the examiners did allow quite a tolerance from 40 s. However it was common to see tangents drawn at $t = 0$ s or even no tangent at all.

Once the tangent had been drawn, most candidates attempted to calculate the gradient. Candidates are encouraged to use a large triangle for this calculation. The most sensible approach is to extrapolate to both axes, increasing the accuracy and simplifying the calculation. Many candidates insisted on using very small triangles and mistakes could then appear when measuring the values of concentration or time and when dealing with unnecessary subtractions.

2(b)(ii) Most candidates divided the value for their gradient from 2(a)(i) by the concentration at 40 s. A concentration of 3.45 mol dm^{-3} was commonly used and a tolerance of ± 0.05 was allowed. It was disappointing in both 2(a)(i) and 2(a)(ii) to see candidates lose marks by careless rounding errors. The units of s^{-1} were usually correct.

2(c) Many candidates identified that water was in excess or that its concentration does not change. A common incorrect approach was to almost repeat the question, i.e. 'the concentration of water does not affect the rate'.

Question 3

3(a) This part was extremely well-answered showing that many candidates are well-rehearsed for this type of question. It was common to see well-presented responses with the correct answer of 16.8 (with no units).

Not unsurprisingly when errors did occur they most often involved calculating the equilibrium concentrations of the three species. Few candidates failed to express their numerical value for K_c to three significant figures.

3(b)(i) This part was a deceptively challenging question, the hardest point being the increased concentration for H_2 . Candidates seemed to conclude that the increase in the concentration of hydrogen would shift the position of equilibrium to the right and so suggested that hydrogen and iodine would both decrease while HI would increase in concentration, forgetting that the initial concentration of the hydrogen was now so much higher than it had been before that this was never going to be the case.

3(b)(ii) Most candidates identified that K_c would decrease but some did not explain why in terms of the exothermic or endothermic directions.

3(b)(iii) The context of this straightforward question, with equal numbers of molecules on each side of the equilibrium, distracted many candidates into claiming that this was the reason why K_c did not change with pressure, rather than K_c being only temperature dependent.

Question 4

4(a) This part was answered very well with many candidates obtaining all five marks. Surprisingly it was more common to see the calculated pH value of 4.14 for $HOCl$ than the easier 0.85 for HCl . It was also quite common to see no comment that HCl is a strong acid and $HOCl$ a weak acid. It seemed that some candidates could not interpret what was required from the unstructured format of the question.

4(b) This type of question asking for full and ionic equations of a weak acid with metals and carbonates has been set often but never with aluminium, resulting in a relatively challenging question. Of the more able candidates, some let themselves down by use of charges in the formula of aluminium ethanoate, in that they only included the charge on the ethanoate ion and not on the aluminium ion. The examiners were surprised at the number of candidates who were unaware of, or who could not work out, that aluminium forms an ion with a 3+ charge. Consequently it was common to see Al^{2+} and Al^+ ions. Some candidates even responded with Mg instead of Al, presumably as the reaction with Mg has featured in a previous examination session and Mark Scheme.

4(c) The vast majority of candidates calculated the correct pH of 13.60 for both marks and this question proved to be one of the easiest on the paper.

4(d)(i) The role of buffers in controlling pH is a common recall question and most candidates had prepared well-rehearsed answers. The hardest part of the question proved to be the equilibrium equation with many attempts at writing down the formula of methanoic acid. It was common to see the equilibrium for the stock example of ethanoic acid instead. Well-prepared candidates were thus able to collect full or nearly full marks for this part. There was a significant minority of candidates who had obviously not learnt this part of the specification and, despite their best efforts to invent answers, there was rarely anything that the examiners could credit. This was a great pity because marks were effectively being thrown away. It was also noteworthy how many candidates, including the more able, simply wrote down all they knew about buffers, including their preparation, rather than tailoring their answer to what was asked in the question. This wastes time that could be better employed tackling more demanding parts of the paper.

4(d)(ii) This part was a challenge for many candidates. Most could give an equation for forming the salt and many were aware that the weak acid was in excess – the calculation was far more of a problem. Many used the initial concentration of the acid and didn't recognise that some would be neutralised. Most candidates identified the concentration of NaOH as 0.40 mol dm^{-3} but they did not then make the jump to 0.40 mol dm^{-3} also being the concentration of HCOO^- . The weakest candidates confused the correct approach with one for calculating the pH of a weak acid and so arrived at expressions that involved taking square roots. About 20–30% of candidates, however, showed excellent understanding and were able to reach the correct pH value of 3.99.

Question 5

This question in many ways discriminated better than any other on the paper. Many weaker candidates were unable to get to grips with the demands of interpreting novel information to construct equations and to identify structures. These were areas in which the very able really shone.

5(a) Surprisingly, more than half the candidates were unable to interpret the information to write a simple equation for the formation of iron(III) chloride from its elements. It was common to see iron(II) chloride as the product and Fe^{3+} instead of Fe as reactant. Some clearly did not recognise the product as being Fe(III) despite the colour clue in the information.

5(b) Compared with (a), this was more familiar territory for candidates and many correct ionic equations were seen.

5(c)(i) As with (a), this part required candidates to interpret unfamiliar information resulting in a challenging question. Able candidates rose to the challenge and were able to construct a fully balanced equation. Some candidates obtained partial success by showing the correct reactants and products – unfortunately charge had often not been considered and the equation had not been balanced electrically. Many responses were extremely wide of the mark, suggesting complexes that incorporated both metals or involving other reagents such as chloride ions. Not to know that a pale green solution here signals the presence of $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ is indicative of a candidate who has not prepared well for this topic. This part discriminated extremely well.

5(c)(ii) The responses here were a mixture of the correct redox, together with ligand substitution, precipitation, reduction or oxidation. Many seemed to guess but the able candidates chose correctly.

5(d)(i) The necessary information required to solve this novel question had been provided but many candidates had little idea of how to proceed and the examiners encountered many strange complexes in the responses seen. If the product formula was correct, balancing was usually also correct but some omitted K^+ if their equation had used KCN as one of the reactants. This was another very good discriminator.

5(d)(ii) In contrast with the responses to (d)(i), most candidates responded with the correct 'ligand substitution'.

5(e) This type of question has been encountered on previous papers and candidates were much more comfortable with drawing optical isomers than constructing equations in earlier parts of this question. Most structures seen were correct though some had charges within as well as outside the brackets.

5(f) This was a very challenging question. Of the allowable alternatives, FeO_4^{2-} was the most common correct answer with $\text{Fe}_2\text{O}_7^{2-}$ being seen on rarer occasions. Most candidates were unable to appreciate the meaning of ferrate(VI) despite the concept being introduced in F321. Many candidates were distracted by the information in the question, with formulae containing a nitrate ion combined with Fe common. Despite the question stating that the ion contained a 2– charge, many responses had other charges or no charge at all.

Question 6

6(a)(i) This part proved to be fairly straightforward, with the expected '218' being seen on the majority of scripts. Weaker candidates tackled the problem by working out the sum of the entropy of the products minus the sum of the entropy of the reactants or simply ignoring the presence of glucose.

6(a)(ii) Most candidates completed this part with ease, competently using the Gibbs' equation and converting ΔS from $\text{J K}^{-1} \text{mol}^{-1}$ to $\text{kJ K}^{-1} \text{mol}^{-1}$ successfully. The commonest errors were to use the answer to (a)(i) instead of 256, not converting 256 to 0.256 or to use the incorrect temperature. In some cases the expression for ΔG was correct but the answer had been incorrectly calculated and here it is important to stress to candidates the need to think carefully about the kind of answer such a calculation is likely to produce and not to follow blindly what is shown on the calculator display.

6(a)(iii) The majority of candidates knew that the answer must involve a discussion about the sign of ΔG but many simply stated that ΔG was positive and did not go on to explain that this was because ΔH was positive and ΔS was negative. Others brought ΔH and ΔS into their argument but only in as much as they stated the ΔH was always going to be greater than $T\Delta S$ without explaining why this was true.

6(b) This proved to be a difficult question. The first hurdle, at which many candidates fell, was to calculate the correct amount of carbon dioxide. Many did not know where to start with this and did not use any of the preceding thermodynamic data while others used their calculated value for ΔG rather than the value for ΔH . Even then, those candidates who used the enthalpy change did not consider the stoichiometry of the reaction and so did not multiply by six. This opening calculation was, of course, unusual and so it is perfectly understandable that many candidates found this a real challenge. In the second part, however, it was notable that even when candidates had gained an acceptable answer to this first step, they then either multiplied by the wrong molar mass or in some cases divided by 44, poor errors for a candidate at this stage. Very few candidates were able to score the available two marks, a real contrast with the ability to deal with the stock rehearsed responses to earlier parts of this question.

Question 7

7(a) This was well answered and most candidates felt on very safe ground here and secured themselves both marks.

7(b) Again, a straightforward test of this basic skill saw nearly every candidate obtain the correct value and so be awarded the mark.

7(c)(i) Although slightly more demanding than the preceding opening parts of this question, this again elicited a good number of perfect answers. Where errors did occur they could often have been put right if candidates had just taken the time to check the balancing of their equations more carefully, particularly in terms of charge. Very few candidates seemed to be unaware of what was required.

7(c)(ii) This part was often well answered.

7(d) This was by far the most challenging question on the paper. Despite candidates being asked to use the table of electrode potentials, most candidates completely failed to realise that they were expected to use the given electrode potential values to answer the question. Only a handful of candidates made any headway in explaining how the reaction is altered in base. Many responses were in terms of oxidation/reduction or electrons lost/gained and did little more than restate the information about the equations given in the stem to the question.

7(e)(i) Overall this was well answered although some candidates did not go quite far enough in explaining why they had suggested IO_3^- as the oxidising agent. The common error was with a choice of the incorrect oxidising agent, usually I or Sn^{2+} .

7(e)(ii) This was a very good discriminator as only the most able candidates were successful. The route to gaining at least the first mark relied on candidates realising that the reaction was in acid and so using H^+ as one of the reactants. Those who did not use this information were often led to having to give O_2 as a product of their equation. If candidates did use H^+ as a reactant they nearly always gained the first mark, although a few gave iodide as a product rather than iodine. The second part of constructing the equation needed candidates to balance the number of electrons involved, or the oxidation numbers, and this they found very difficult. Again it was notable how many of the final equations could be seen to be incorrect from looking at the balancing of the charges on the ions, suggesting that many candidates simply do not do this as a matter of course. When species were correct, balancing of the tin ions was often incorrect.

Question 8

8a This was well answered with all but the weakest candidates gaining both marks. Fewer candidates removed 3d, rather than 4s, electrons than in past sessions.

8(b)(i) Although many explained that ammonia was accepting H^+ ions, they did not go on to state the role of ammonia as a base. Weaker candidates thought of ammonia as removing hydrogen and so gave answers in terms of a redox process occurring while others suggested that ammonia might be a catalyst or a ligand.

8(b)(ii) Almost all candidate correctly showed the required '4'. The few incorrect responses were almost exclusively for '2'.

8(b)(iii) This part was well answered and it was only a failure to explain the answer fully that cost candidates the mark here with some suggesting that DMG had a 2-, rather than a 1-, charge or others simply stating the charges but not explaining that their cancelling made the complex neutral.

8(b)(iv) Candidates had more difficulty with this part. The commonest errors seen were a O^- charge on one end of the molecule or an extra H on an O atom.

8(c) Most candidates attempted this unstructured problem and this part was a very good discriminator, with only the very best candidates achieving full marks. The biggest problem was the lack of logical setting out of the calculation with most candidates writing down numbers in random places on the page.

Virtually every candidate was able to make some progress. The most commonly awarded marks were those for the amount of $\text{Ni}(\text{DMG})_2$, the mass of water and the amount of water, and at this point weaker candidates tended to retire. The next cohort went on to use these numbers to work out the number of waters of crystallisation. The final step needed to determine the identity of the anion and was naturally the most challenging, requiring some chemical feel and flair.

Some candidates assumed the anion to be DMG^- and so stopped at proposing the formula as $\text{Ni}(\text{DMG})_2 \cdot 7\text{H}_2\text{O}$. Overall, however, it was very encouraging to see that a reasonable number of candidates worked thoughtfully through this problem to arrive at the correct answer, recognising that a number close to 96.1 signalled a sulfate.

This question was a good exercise in extracting the correct data from provided information and then working out what to do with it.

F326 Practical Skills in Chemistry 2 (Coursework)

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 generally equally represented and the range of marks obtained by candidates was equivalent. The majority of centres are carrying out more than one Task in each category although it appeared that the use of only one Quantitative Task was not unusual.

Centres should be careful to check the addition of marks on candidates' scripts. There appears to be more mistakes in the overall addition of the three component marks than in previous years. It is essential that careful checking be 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. It must be clear though, which mark is to be used if there is a difference arising from internal moderation.

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. 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 with 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.

Candidate performance

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. Generally, candidates either cope very well gaining the majority of the marks or candidates run into difficulties and the marks are far lower.

Qualitative Tasks

The quality of the work received was generally good with Task 1 and Task 2 being seen by the Moderators slightly more often than Task 3. When the marks awarded for some of the observations were generous it was because the marking points from the published Mark Scheme had not been matched due to incomplete or inaccurate observations. The use of 'benefit of the doubt' is not always appropriate as the Mark Scheme is usually explicit as to what is acceptable. In particular, where the Mark Scheme requires two or more observations to be made, a mark cannot be awarded if all have not been recorded correctly.

The difference between ion charges and oxidation numbers also needs to be clear and this caused some difficulties in Task 3 when both were required.

Equations must be written as shown in the Mark Scheme and should be balanced with state symbols when specified to gain a marking point.

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 to GCEScienceTasks@ocr.org.uk.

If a centre then changes the expected observations from the Mark Scheme and these have been approved by OCR, candidates can only gain credit if their results then match the centre-agreed observations.

Quantitative Tasks

Centres are reminded that the sample provided should include 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. To aid this process, the use of the look-up tables supplied with the Quantitative Tasks is to be encouraged. There were a number of instances where centres had incorrectly awarded accuracy marks as no allowance had been made for the difference between candidate and teacher masses.

When difficulties do arise they are mainly the recording of results to the correct number of decimal places or significant figures. The guidance in both the question and Mark Scheme must be followed.

Another common problem was using a snapshot of the rates Task to explain the order of a reaction rather than referring to the proportional link between rate and concentration.

In the Quantitative Tasks, centres are generally consistent in awarding 'benefit of the doubt'. Candidates performed the Quantitative Tasks to a high standard and were able to manipulate their results with confidence, usually scoring their highest marks for these Tasks.

Evaluative Tasks

The Evaluative Tasks caused the most difficulty for both candidates and centres despite many candidates dealing easily with calculating errors and assessing the accuracy of different apparatus used within a particular exercise. Candidates found linking electrode potentials to experimental outcomes difficult and also linking K_c to experimental changes proved problematic for some. The generous use of 'benefit of the doubt' was widespread and centres must be cautious that, where alternative wording is credited for explanations, the response closely matches the Mark Scheme requirement.

When equations are asked for, the only alternatives allowed, other than multiples, are those given in the Mark Scheme and care must be taken that the correct species are used.

Even more care must be taken at this level with correct terminology being used in explanations. For example, the use of mass in place of moles, and volume instead of concentration, are common issues. When observations are linked to a process, for example, heating to constant mass, the process must be mentioned, i.e. heating.

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