

Chemistry A

Advanced GCE A2 H434

Advanced Subsidiary GCE AS H034

Reports on the Units

June 2010

H034/H434/R/10

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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.

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Advanced Subsidiary GCE Chemistry (H034)

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Chief Examiner's report

General comments

This focus of this series has been the first aggregation of the A Level qualification, H434, in OCR's revised Chemistry A specification. The AS Chemistry specification, H034, has seen centres becoming more acquainted with teaching the course, the examination papers and the assessment of practical skills.

The transition from the old legacy specification to the revised A-level has presented considerable challenges in the A2 year for teachers and their students. The specification is in some areas very different and teachers have sometimes had to prepare a considerable amount of new teaching material. In the units of assessment, candidates are now required to apply their knowledge and understanding to a much greater extent than in the old legacy specification. The assessment model provides the opportunity for more demanding stretch and challenge questions that will help inform the new A* grade available to aggregating candidates of the new A level. This also has a knock-on for how the course is delivered.

To provide for the full range of successful assessment grades from A* to E, the A2 papers have presented candidates with more questions that have been set in an unfamiliar context, sometimes assessing a wide range of different skills. Many teachers have looked forward to the new papers in anticipation of how the style will have changed. What is clear is that, in the A2 units, F324 and F325, rote recall of the course content is unlikely on its own to guarantee a good result.

Candidates are advised to use the available time for the papers wisely and not to get bogged down with overlong responses to early questions that may prevent a proper attempt at later questions. Experience from marking the A2 units shows that some candidates have used their time poorly. This was particularly the case in the shorter unit, F324. Next year's A2 papers have been set in a similar style with a mixture of questions assessing learnt chemistry from the unit and questions that assess candidates ability to apply their knowledge and understanding. In preparation for future papers, teachers are advised to use more application-based problems and to emphasise the importance of time management within the examinations.

A final general comment relates to candidate performance on the new A2 papers. Overall, candidates have responded to the challenge admirably. Having been exposed to some very demanding questions, the very best candidates have responded extremely well and have been able to demonstrate some very high quality responses. All candidates have been able to demonstrate their knowledge and understanding about chemistry at this level. The outcomes from this series represent a real achievement for successful candidates.

Note regarding Stretch & Challenge (A*) for June 2010

June 2010 sees the first award of the A* grade for new GCEs (see page 70 of the specification). To achieve an A* grade in their Advanced GCE, candidates must achieve 480 *uniform* marks (UMS) in their Advanced GCE, *ie* grade A, and also gain at least 270 *uniform* marks in their three A2 units. Two candidates with 480 UMS could have different grades depending on their AS and A2 performance, for example:

Candidate 1 – 211 UMS at AS, 269 UMS at A2, 480 UMS overall, grade A

Candidate 2 – 210 UMS at AS, 270 UMS at A2, 480 UMS overall, grade A*

A good explanation is given in the open letter to centres from OfQual, see www.ofqual.gov.uk/files/2010-02-11-open-letter-a-star-grade.pdf and also see www.ocr.org.uk/qualifications/type/gce/stretch_challenge/

Upcoming INSET events in 2010/2011

OCR AS/A Level Chemistry A (H034/H434): *Get ahead – raising standards through exam feedback (Course code OSCM3)*

This **full day** course will:

- Consider post-summer results documentation, such as question papers, reports and Mark Schemes
- Consider the step up from AS to A2
- Discuss approaches for preparing candidates for the external examination
- Demonstrate standards for the internal assessment of coursework and externally assessed components
- Allow delegates to share good practice and ideas on new approaches.

Course dates – Friday 24 September 2010 (London), Wednesday 3 November 2010 (Birmingham). We would also like to run this course in York and Belfast (along with a second event in London) if there is sufficient interest from customers. Please visit EventBooker or e-mail training@ocr.org.uk to register your interest. We will contact you with details as soon as we confirm a date and location.

Fee – £182 including refreshments, lunch and course materials. £215 if you book within 7 days of the course date.

OCR AS/A Level Chemistry A (H034/H434): *Get Started – successful first delivery (Course code OSCM2) (Note: this course is an updated version of the sessions that ran in previous years.)*

This **full day course** will:

- Answer questions from teachers linked to the teaching of the standards
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- Enable delegates to network and share ideas for best practice.

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F321: Atoms, Bonds and Groups

General comments

This paper was sat by over 17000 candidates, a significant increase on last summer's entry, with a considerable number of candidates taking the opportunity to re-sit prior to certification of results.

The paper sets out to examine basic principles such as reactivity, periodicity, structure and bonding as well as the ability to handle chemical calculations. These are ideas and skills which underpin much of the remainder of the A-level course. Many of the candidates who took this paper had clearly mastered these basic principles, and answers displayed a pleasing level of understanding.

Candidates were generally well prepared and many good scripts were seen. However, even the well prepared candidate should ensure that they do not fall into the habit of jumping too quickly to the answer they think is correct without fully reading the question. This was evident in this paper both in **5(c)(i)** where some candidates gave the lithium ion an inner shell of eight electrons and in **4(b)(i)** when candidates did not fully explain the link between oxidation/reduction and changes in the oxidation number.

The use of significant figures was specifically tested in only one place, **1c**, but candidates should be aware that cavalier approaches to rounding, assuming the rounding is correct, will lead to ridiculous answers. As a general rule, one would expect titration calculations to have three significant figures. Rounding to one significant figure is equivalent to carrying out a titration with a measuring cylinder rather than a burette.

Comments on individual questions

Question 1

(a)(i) This was a very straightforward question with which to start the paper. The vast majority of candidates took the opportunity to score their first mark.

(a)(ii) Here again nearly every candidate was able to describe the difference between these two isotopes in terms of their relative number of neutrons. Even candidates who had slipped up in their answer to part **(i)** often redeemed themselves here and picked up this mark.

(b) This familiar question was well answered by most candidates. A common error to be avoided is comparison of the atomic level with the mole level. For example, 'The weighted mean mass of an *element* compared to 1/12 the mass of an atom of carbon-12' does not compare the average mass of an atom with atoms of carbon-12. Another way in which candidates mixed up the atomic level and the mole level was by comparing the weighted mean mass of an atom with 12 **g** of carbon-12.

(c) Many weaker candidates struggled with this question. Potential pitfalls presented by this particular problem were to forget to convert 2.08 kg into 2080 g, or to divide by the Avogadro constant. The first error is an understandable slip but the second is more serious as it reveals a candidate who is simply going through the mathematical motions and not giving a thought to the final answer being less than one atom.

It was surprising to note how many candidates chose to use their own version of the Avogadro constant rather than the value given in the *Data Sheet*.

(d) A surprisingly large proportion of candidates were unable to gain both marks. A significant minority chose to use 118 as the relative atomic mass of tin – once again candidates are reminded to make full use of the *Data Sheet*.

Question 2

(a)(i) Most candidates answered this without difficulty. H^+ was almost universally seen. SO_4^{2-} was less common. HSO_4^- for the anion was not uncommon. The most common incorrect ion to be suggested was OH^- . The lack of clarity of subscript and superscript notation in the SO_4^{2-} ion was disappointing in some cases.

(a)(ii) Most candidates scored well here. Most pointed out that the reaction would result in effervescence and many of these were also able to give a correct equation. Slightly fewer candidates remembered to point out that the carbonate would dissolve. Many who did describe the dissolving of the solid also incorrectly described the appearance of a precipitate. Weaker candidates clearly became confused with the addition of potassium to water and described the evolution of hydrogen or how potassium moved over the surface of the water. Such answers were very much in the minority.

(b)(i) Most candidates were able to manipulate the volume of acid and its concentration to arrive at the correct answer. There were a surprisingly high number of transcription errors and clearly many weaker candidates have difficulty converting from standard form to decimal form.

(b)(ii) Most candidates were able to use the stoichiometry of the reaction to arrive at the correct answer by simply doubling their answer from part **(i)**. A small minority muddled the ratio and gave a value which was half that of their answer in part **(i)**.

(b)(iii) This was a demanding calculation and discriminated well amongst the top end of the cohort. The open nature of the calculation proved to be a problem for many. Most were able to convert the number of moles of NaOH in **2(b)(ii)** to a mass in grammes. The common error then seen was the failure to multiply this by a factor of 10 to find the actual mass of NaOH in 2.00 g of the tablets. Consequently 9.84% was a commonly seen response. Many, equally acceptable, alternative routes through the calculation were seen.

Question 3

(a) This question was extremely well answered and only the very weakest candidates failed to be awarded this mark. For this paper, candidates were allowed the use of a capital D for the 3d sub-shell label but candidates should use the correct, lower case, sub-shell notation so in future 3D is unlikely to receive credit.

(b)(i) The correct definition for an orbital eluded many candidates. Although most had some idea about an orbital either in terms of its being a constituent of a sub-shell or in terms of its being a region of space which contains electrons, relatively few candidates were able to give a sufficient description to merit the mark. The expected response was the definition seen in the specification. Loose responses such as 'a place where electrons are found' would not distinguish an orbital from a sub-shell or a shell.

(b)(ii) This relatively easy question did not distinguish well. Many strong candidates gave the answer '5' without giving due care to the question posed which asked for the *total* number of p electrons in a chlorine atom.

(c) The vast majority of candidates gave correct answers here. Strangely, when an incorrect response was seen, 15 was often the value given.

(d)(i) This unusual method of testing the understanding of ionisation energy proved to be a difficult question. Of the two correct pairs, the pair involving the second and third ionisation energy was more commonly seen. This presumably means these candidates were not using the electronic structure of aluminium to work out which ionisation energies involved s electrons but rather were using that fact that removal of the two s electrons always directly precedes a sharp increase in ionisation energy.

(d)(ii) As has been the case with such questions in previous papers it is always slightly disappointing how many candidates either fail to give state symbols or more commonly refer to the aluminium ions as being solid. Candidates do need to be aware of clarity and legibility of handwriting. Bizarrely, many scripts had state symbols of which it was very difficult to decide whether (g) or (s) had been written.

Question 4

(a)(i) This question distinguished well across the cohort. The most common score was 1 mark, usually for realising that experiment 1 would result in the cyclohexane layer turning purple. Many candidates failed to appreciate that the cyclohexane was added to the aqueous mixture so responses such as 'no change' or 'colourless' for experiment 3 were inappropriate as the halogen present would cause the organic solvent to become coloured.

(a)(ii) This ionic equation was well known. Fortunately for many candidates, the appearance of state symbols was ignored whether correct or not. Had state symbols been asked for then the number of candidates scoring the mark would have been greatly reduced.

(a)(iii) More candidates got this question wrong. A very common error was to confuse halogens with halides and so a number of candidates proposed tests based on the use of silver nitrate.

(b)(i) This question on disproportionation was a familiar one. Many candidates scored all three marks. Of the three marks on offer here, that for assigning the correct oxidation number was awarded the most frequently, although it is noteworthy that a number of candidates who went on to gain the remaining two marks did forget to assign a zero oxidation number to chlorine in Cl_2 . For the remaining marks the candidate had to show that chlorine has been both oxidised and reduced and link this to the relevant species either directly or through its oxidation number. Many candidates failed to pick up both these marks as their answers were too vague. Thus, although they pointed out that oxidation and reduction had taken place since the oxidation number of chlorine had both increased and decreased, they did not make clear the link between oxidation and an increase in oxidation number, and the link between reduction and a decrease in oxidation number. It is very important in these questions that a degree of familiarity does not make candidates rush and so fail to answer the question fully.

(b)(ii) Most candidates were able to state a benefit from the chlorination of water. A few weaker candidates focussed on the toxic properties of chlorine and so argued that dissolving in water would remove a toxic gas.

(c)(i) Although many candidates did gain this mark, the most common error was to give an answer of simply 'decomposition', which was not sufficient for the mark (which required *thermal* decomposition). Weaker candidates often gave 'redox' as an answer, perhaps being influenced by the previous question.

(c)(ii) The majority of candidates achieved both marks here. Where there were problems they tended to be in the second half of the calculation. Most candidates were able to convert the mass of magnesium carbonate into a number of moles but then either divided by 24 or in some cases multiplied by 24000 to give an incorrect answer. A significant number of candidates

chose to round the answer to the first step of the calculation ($1.47/84.3$) to one significant figure thus giving a final (incorrect) value of 0.480 dm^3 .

(c)(iii) Candidates found this a challenging question. The most common source of error was to confuse the trend in the reactivity of the metals with that of the compounds. A good candidate should know that these will be opposites. Consequently, many candidates thought that the carbonates would become easier to decompose as the group was descended.

Question 5

(a) This was another familiar question. Overall, the quality of the diagrams seen was good. Occasionally the metal ions were much too randomly placed to have been considered to lie in a regular array but overall it was common to be awarding two marks here. In the description of the bonding that followed the most common error which prevented the mark being awarded was when candidates referred to the attraction between ions and electrons as being '*intermolecular*' or '*inter-atomic*' in its nature.

(b)(i) This was very well answered with the vast majority giving a correct '*dot-and-cross*' diagram. The only recurring error was one where candidates had used all crosses in the diagram except for a single dot in the shared pair.

(b)(ii) This was well answered considering confusion that such questions have revealed in the past. Of course, there were some candidates who suggested that the covalent bond breaks when fluorine enters the gas phase but such answers were relatively rare.

(c)(i) The answers seen were generally of a high standard. Of the possible errors the most revealing was that which saw eight electrons in the inner shell of the lithium ion. This again hints at a candidate who, recognising the type of question, moves too quickly to give the answer without considering it fully.

(c)(ii) This question did not witness a marked improvement in the quality of responses from previous series. There are still too many candidates who want to describe the conductivity of molten salts in terms of the movement of electrons rather than ions.

(d)(i) The more able candidates coped with this unfamiliar equation well but others struggled to get the equation to balance and often resorted to using F in place of F_2 . As candidates do not study the chemistry of boron, it was felt that some leniency be shown for the use of diatomic boron, B_2 , but this may not always be the case.

(d)(ii) Many candidates correctly identified the shape of BF_3 as trigonal planar although some did not spell the technical name correctly as instructed on the question paper and so were not awarded the mark. With the shape stated correctly these candidates nearly always went on to give the correct bond angle. Some candidates clearly confused the shape of BF_3 with that of NH_3 and so did not gain either of these two initial marks. When it came to the explanation of the shape, most candidates were able to describe the part played by electron pair repulsion although not all candidates were careful enough to ensure their description referred to repulsion between electron *pairs*. The final mark for identifying the number of bonded pairs was the least often awarded.

(e) Although many candidates were able to state that fluorine was more electronegative than nitrogen, some then became confused by the presence of the lone pair and so reasoned that the N rather than the F would carry the partial negative charge. For the second mark there were relatively few candidates who were able to point out that the molecule being pyramidal in shape does not have sufficient symmetry for the dipoles to cancel.

(f) Overall, this was an extremely well answered question. Nearly all candidates knew that the radius decreases across the Period and that this is a result of the increasing number of protons. For those candidates who only scored three marks in this question, the omission of either a statement about nuclear attraction or about shielding was evenly balanced. Notably a few candidates confused the trend in ionisation energy with that of atomic radius and so suggested that there would be a slight increase in radius on going from beryllium to boron because of the occupation of the new sub-shell. This is not an unreasonable suggestion and the fact that no such increase occurs should perhaps be stressed when teaching this topic.

F322: Chains, Energy and Resources

General comments

The cohort for this component had increased significantly from the June 2009 series. This increase was due to both new candidates and an increased number of re-take candidates.

The paper differentiated well and candidates were awarded marks that almost covered the whole mark range. It allowed candidates of all abilities to demonstrate positive achievement. There was very little evidence that candidates did not have sufficient time to complete the examination paper.

A significant proportion of candidates wrote incorrect equations and did not check that they were balanced. Many candidates also found the questions that involved long answers were demanding. These candidates often did not organise their answers by using information in the stem of the questions. Good answers to these types of questions were well organised and concise.

Candidates generally performed well in calculation questions but were sometimes let down by incorrect use of significant figures, standard form or decimal places.

Comments on individual questions

Question 1

This question focussed on aspects of the chemistry of alkynes and was the least demanding question in the examination paper.

(a) In (i), many candidates could not give an accurate definition for the term homologous series. The correct answer required reference to the same functional group and a general formula or the idea that each member varies by a CH_2 group. A significant proportion of candidates only referred to one of these ideas and this was not given a mark.

In **(ii)**, many candidates could explain why the boiling points of the alkane homologous series increase. Candidates typically referred to the increase in chain length, increase in molecular size or increase in electrons and related this to an increase in the van der Waals' forces. It was not sufficient to just refer to intermolecular forces. Only a small proportion of candidates referred to breaking covalent bonds.

(b) Most candidates found **(b)** straightforward with the exception of **(iv)**.

In **(i)**, pentyne, pent-1-yne and pent-2-yne were all allowed in the Mark Scheme.

In **(ii)**, most candidates could deduce the general formula for an alkyne; some candidates gave $\text{C}_{n+1}\text{H}_{2n}$ which was also given credit.

In **(iii)**, only a displayed formula was allowed. Although most candidates could complete the formula some included pentavalent carbon atoms.

Candidates found **(iv)** very challenging and typically a cyclic structure with a triple carbon-carbon bond was drawn. Only a small proportion of candidates failed to draw a skeletal formula.

(c) Most candidates were able to calculate the answer as $-1236 \text{ kJ mol}^{-1}$ but many of the other candidates had the cycle the wrong way round and got $+1236 \text{ kJ mol}^{-1}$. Only a very small proportion of candidates were unable to gain at least one mark.

(d) In **(i)**, many candidates could give an accurate definition for the standard enthalpy change of formation. Most errors were due to omission, for example failing to refer to one mole of a compound or that the compound was formed from its elements. A common misconception was to refer to the enthalpy change when a compound was made from one mole of its elements. The standard conditions were well known by candidates; reference to a 1 mol dm^{-3} concentration was ignored. Many candidates could complete the calculation in **(ii)** and obtain the answer of -128 kJ mol^{-1} . Only a small proportion of candidates obtained the answer $+128 \text{ kJ mol}^{-1}$.

(e) In **(i)**, many candidates could calculate the atom economy of the reaction to be 26.0. A small proportion of candidates calculated the atom economy for calcium hydroxide instead; these candidates scored one mark.

In **(ii)**, many candidates obtained the answer of 15600 mol.

In **(iii)**, far fewer candidates were able to do the calculation because they did not use the molar volume of ethyne; instead they carried out another calculation involving molar mass. The correct answer for **(iii)** was 15000 mol.

In **(iv)**, an error carried forward mark was allowed for from **(ii)** and **(iii)**, the correct answer being 96.2%. In this question the answer had to be quoted to at least two significant figures up to the rounded up or rounded down calculator value.

In **(v)**, although some candidates could relate the poor atom economy with a lack of sustainability, fewer candidates suggested that a use for calcium hydroxide needed to be found. Error carried forward was applied in **(v)** to allow for an incorrect atom economy calculation.

Question 2

This question focussed on the combustion of fuels used in transport.

(a) Many candidates could name a branched chain alkane. The most common misconceptions were the use of a 1-methylalkane or a 2-ethylalkane.

(b) In **(i)**, most candidates were able to describe that infrared radiation makes bonds vibrate. Stretching or bending bonds was also allowed but breaking bonds was not.

In **(ii)**, almost all the candidates appreciated that carbon monoxide was made due to lack of oxygen or incomplete combustion.

In **(iii)**, only a very small proportion of candidates could not get at least one mark. Candidates needed to be precise about the environmental impact of NO because at low altitude it forms ozone and at high altitude it removes ozone. Reference to NO causing acid rain was allowed on the Mark Scheme. In terms of CO most correct answers referred to its toxic nature or that it reduces the oxygen-carrying ability of blood. Some candidates gave too much detail about the reaction between haemoglobin and oxygen without stating that CO was toxic or would kill.

(c) Although many candidates obtained full marks for **(i)** others only gave the formulae of the gases made rather than their names. A common error was to give the name as nitrogen dioxide rather than nitrogen.

In **(c)(ii)** only the most able candidates were able to score full marks. A common error was to only draw one of the two required diagrams. Many candidates did not include the correct labels for the axes for the enthalpy profile diagram and Boltzmann distribution. Candidates also need to take more care when drawing arrows to represent activation energy and the enthalpy change. Often candidates drew the enthalpy change with a double headed arrow which was not given credit; however this was allowed for the activation energies. Candidates also need to be careful that the lines start and finish at the correct place. Only a small proportion of candidates could not draw an acceptable Boltzmann distribution. However, some candidates drew two curves one for non-catalysed and one for catalysed. The idea of more successful collisions was not always expressed clearly.

(d) Many candidates could give at least one advantage and one disadvantage. The idea of biodiesel being 'carbon-neutral' was given credit but some candidates went much further and explained why the biodiesel was carbon neutral. Many candidates realised that biodiesel was more sustainable but far fewer candidates explained that the change to biodiesel would reduce the reliance on a non-renewable fuel. Candidates often mentioned the conflict between growing crops for food or for biodiesel as a disadvantage. A common misconception was to state that it takes a longer time to form biodiesel forgetting the millions of years needed to make crude oil.

Question 3

This question focussed on the chemistry of butan-1-ol.

(a) A small but significant proportion of the candidates did not attempt **(a)**. This question gave excellent discrimination and only the most able were able to score maximum marks. Candidates were more likely to get the two oxidation products than the other two products. Some candidates wrote the aldehyde functional group as COH rather than CHO and were not given credit. The dehydration product was often incorrect with butane and but-2-ene being popular incorrect answers. Many candidates missed out the ester product while others gave the wrong ester as ethyl butanoate. In this question structures or correct names were acceptable.

(b) Both S_N1 and S_N2 mechanisms were allowed in the Mark Scheme for **(i)**, although most candidates gave the expected S_N2 mechanism. Often candidates were not awarded full marks because of a lack of care when drawing the mechanism. Typically the partial charges on the C–I bond were drawn correctly but the curly arrow representing the heterolytic fission of this bond often started from the carbon atom rather than the bond. A small proportion of candidates did not draw out the structure of 1-iodobutane in full and so found it difficult to draw suitable curly arrows or partial charges. There was no need to show the lone pair on the hydroxide ion but candidates had to draw the curly arrow from either the negative sign or a lone pair. The name of the mechanism and the type of bond fission were well known.

In **(ii)**, many candidates realised that either more heating or more time was needed for the reaction although due to lack of precision in the use of language they often did not get the explanation mark. Candidates needed to describe the differences in the carbon–halogen bond enthalpies in both compounds rather than just stating the bonds were weaker in 1-iodobutane.

Question 4

This question focussed on the use of infrared spectroscopy and mass spectrometry in the analysis of organic compounds.

(a) Most candidates could quote two characteristic infrared absorptions in **(i)**.

The colour change in **(ii)** was generally well known.

Candidates found **(iii)** much more demanding and only the most able were able to score full marks. A typical misconception was to give hydrogen as a product of the reaction. Candidates were not penalised the equation mark if they gave molecular formulae or incorrect structures such as CH_3COH , but had to give a correct structure of the oxidation product to gain full marks.

(b) In **(i)**, candidates often referred to the presence of an absorption peak at 2900 cm^{-1} as due to a C–H bond stretch. Only a small proportion of candidates referred to the lack of any other characteristic infrared absorptions. Credit was not given for the comment that there were no other absorptions because there were some small absorptions in the fingerprint region of the spectrum. Many candidates tried to use mass spectrometry data which was not given credit.

In **(ii)**, candidates who labelled the $m/z = 58$ peak on the mass spectrum helped the Examiner award the mark, since the use of 'largest m/z peak' could be either $m/z = 43$ or $m/z = 58$.

In **(iii)** candidates had to draw just two isomers; candidates were not given credit if they drew the same isomer twice. A common misconception was to draw butane twice.

Only a small proportion of candidates got full marks for **(iv)**. Typically candidates did not include the positive part of the fragment ion.

In **(v)** candidates often recognised that the isomer was butane but did not necessarily give an adequate explanation. Candidates had to mention the absence of the $m/z = 29$ peak in the mass spectrum of 2-methylbutane. A significant proportion of the candidates did not attempt this part question.

Question 5

This question focussed on the chemistry of alkenes.

(a) The best answers gave two fully labelled diagrams, one showing sideways overlap of $2p$ orbitals and the second the π -orbital above and below the σ -bond. Candidates found this question very difficult.

(b) In **(i)**, candidates were often able to state that a carbon–carbon double bond does not rotate but could not explain with sufficient clarity that each carbon atom of the double bond has two different groups attached.

Almost all candidates in **(ii)** could recognise the *E/Z* isomers.

(c) Most candidates could identify ethanol as the major product.

(d) Candidates of all abilities were able to attempt **(d)** and gain some credit. Many candidates could give the correct product of the reaction of **D** with HBr and wrote an appropriate equation. Candidates need to take more care when drawing the electrophilic addition mechanism. Common errors included drawing a curly arrow from a carbon atom rather than from the double bond, showing the heterolytic fission of HBr by having the curly arrow starting from a hydrogen atom, failing to draw the positive charge on the carbocation and not starting the curly arrow from the bromide ion from either a lone pair or the negative sign. A small proportion of candidates had the wrong dipole on the HBr molecule and some had a mechanism that had the correct carbocation being attacked by a hydride ion. Candidates found the reaction of **B** with HBr much more difficult to explain and some candidates gave products involving the breaking of a carbon–carbon bond. Often candidates did not get the equation mark with the reaction of **B** with HBr because it included both products and so did not balance. The Quality of Written Communication mark was the most demanding mark as it involved an explanation for why **D** gives one product and **B** gives two products. Candidates who referred to **B** as being an asymmetric alkene and **D** as a symmetric alkene were more likely to be awarded this mark.

(e) Many candidates could draw a section of the polymer in **(i)** but far fewer candidates could name the polymer in **(ii)**. A typical incorrect answer was poly(ethylethene) rather than poly(but-1-ene). Poly(butene) was not given credit in the Mark Scheme.

(f) Candidates often gave imprecise answers to **(i)** and although they referred to the presence of OH groups it was not clear if these were part of the polymer or water. Common misconceptions included references to OH ions or molecules.

In **(ii)**, candidates needed to be more detailed than just stating that polymers could be recycled. Candidates needed to refer to sorting plastics prior to recycling. Other candidates referred to the cracking of polymers, combustion of polymers for energy generation and being used as a feedstock for organic compounds. Reference to biodegradable plastics was ignored since the question was about how waste polymers could be processed.

Question 6

This question focussed on the manufacture of nitric acid from the catalytic oxidation of ammonia. This was the most demanding question in the examination paper and a significant proportion of candidates did not attempt both parts of **(c)**.

(a) Good answers showed the link between the position of equilibrium and changes in temperature and pressure. Other candidates failed to make a clear link, for example stating that the conditions moved position of equilibrium to the right because the reaction was exothermic without referring to the low temperature.

(b) Many candidates realised that the conditions chosen would increase the rate of reaction but only a much smaller proportion of candidates could explain that the conditions were a compromise between a fast reaction and having the position of equilibrium on the right.

(c) Only a small proportion of the candidates in **(i)** realised that the 909 kJ of heat released comes from 4 mol of NO; so the correct answer was 5.68×10^7 kJ.

In **(ii)**, candidates needed to be more specific in their answers – it was not sufficient to write that energy would be provided.

Question 7

This question involved the interpretation of data and had one mark associated with the assessment of Quality of Written Communication. Candidates had to link the evidence in the question with the structure of the unknown compound.

Candidates of all abilities were able to gain some credit in this question. The most accessible marks involved the interpretation of the infrared data. Candidates were most likely to miss the mark for the absorption at 2900 cm^{-1} because the Mark Scheme required reference to an O–H group in a carboxylic acid.

Many candidates were able to use the percentage composition data to calculate the empirical formula as CHO_2 . Together with the volumetric analysis, able candidates could calculate the relative formula mass as 90 and as a consequence the molecular formula as $\text{C}_2\text{H}_2\text{O}_4$.

Some candidates were able to draw a correct structure for **G** but many candidates had structures which had carbon atoms with less than four bonds around them and oxygen atoms with just one bond.

F323: Practical Skills in Chemistry 1

General comments

There has been a sizeable increase in entry at AS caused primarily by some centres aggregating for AS at the end of the two-year A-level course and also due to retake candidates repeating individual Tasks.

In the vast majority of cases candidates' work was of a very high standard and it was clear that a great amount of time had been spent carrying out suitable practical activities in preparation for the Tasks. Unfortunately some centres carry out the Tasks too early, perhaps without having checked carefully the guidance within the Task Instructions, leading to candidates not being able to answer a part of a Task. This was most frequently seen in the Qualitative Tasks where, although candidates could make and record the required observations, they could not adequately explain them or write balanced equations for the reactions observed.

The marking of candidates' work had been carried out rigorously in the vast majority of samples moderated and it was clear from annotations how and why the marks had been awarded by teachers. Moderators sometimes found it difficult to support the centre judgements when it was unclear from teacher comments or annotations how the marks had been awarded when the responses did not meet the marking points in the published scheme.

Very few centres needed any adjustment to their submitted marks and once again, although the majority of adjustments were downwards, some centres saw their marks increased.

Administration

Clerical errors still have a significant impact on the speed of moderation as well as on the marks of individual candidates. The number of clerical errors decreased from last year but this still is a major problem in about 20% of centres.

Clerical errors as last year resulted from:

- Incorrect totalling of marks within the Tasks
- Incorrect transfer of marks from the pages within a Task to the front cover
- Failure to mark a whole page or pages of a Task
- Incorrect addition of the three marks making up the total for the unit.

It must be emphasised that it is the centre's responsibility to ensure that the marks submitted reflect accurately the work of their candidates. One candidate sampled this year had been given seven marks less than their work merited due to the scores on the Tasks being incorrectly added together whilst another was ten marks short as the centre had shaded in the incorrect boxes on the MS1. These errors were highlighted by Moderators and the candidates concerned had their marks corrected saving any potential embarrassment for the centre on results day.

Centres are advised in future to carefully check the adding up of marks within scripts and then use the OCR 'Marks spreadsheet' available from Interchange (from the Supporting Materials section of the GCE Chemistry A page) to add the marks for the best Task in each category.

Centres should only use valid Tasks for the assessment of their candidates' practical skills. Thus in the period 1 June 2010 to 14 May 2011 the only Tasks that should be used by candidates for practical assessment are those from Interchange carrying the date 1 June 2010 to 14 May 2011.

Centres must check before carrying out a Task that the correct period of validity is printed on the front of the Task and in the footer of each page and must not continue with an assessment if this is not the case. Similarly the dates on the marking schemes should also be checked before any marking is carried out (Tasks should always be marked using a Mark Scheme carrying the same date footer).

Sending work to the Moderator

When work is sent to the Moderator, centre results must be provided in order that the Moderator can check the accuracy marks allocated in the Quantitative Tasks. Failure to submit these will initially result in either a letter or a phone call requesting the centre values. Should the centre not be able to find these results, the whole coursework sample will be returned to the centre un-moderated until some centre results can be generated.

For a Task requiring centre results, OCR provides a table at the end of the Mark Scheme for that Task to be completed for each teaching group. This facilitates the collection of centre results. Where a centre has more than one teaching group, the centre should indicate which candidates have been assessed against which centre values.

For the candidates selected for moderation, the centre should only send the highest scoring Task from each of the categories (Quantitative, Qualitative and Evaluative). Sending more than three Tasks for any candidate delays the moderation process and will result in centres being asked to re-submit their samples according to the regulations set out in the specification and Practical Skills Handbook.

Teachers in centres are advised to consult with the Practical Skills Handbook for Chemistry A, available on the OCR website and on Interchange.

Where a centre submits marks which cannot be supported by the Moderator due to an invalid order of merit, the work will be returned to the centre with an accompanying e-mail outlining any issues. The centre will be asked to reassess the work by referring to the advice given by the Moderator and then to re-submit their marks. A number of centres where one or more candidates' marks were significantly out of line have been asked to re-mark their coursework this year.

Update on the assessment model (see the FAQs available on Interchange)

Note that Tasks completed remain confidential and assessment material should not be returned to candidates.

Only OCR Tasks from Interchange clearly marked with the current assessment year should be used for assessment. For example, if a candidate wishes to improve their mark they could re-submit their best 1 June 2009 to 14 May 2010 Qualitative and Quantitative Tasks along with a **new** (from the 1 June 2010 to 14 May 2011 selection on Interchange) Evaluative Task.

Note that re-submitted work should not go back to the candidate for re-drafting.

The marks confirmed by the Moderator when the Task was first submitted cannot be 'carried forward'. Teachers may re-mark the Task in light of any comments made by the original Moderator (the Archive Mark Schemes are available on Interchange for this purpose) and it will be re-moderated when it is re-submitted. Up to two Tasks per student may be re-submitted from a previous series.

Reports on the Units taken in June 2010

Centres should retain Tasks securely until such time as they are clear that candidates will not wish to re-submit work to OCR in future sessions. At this point the work should be securely destroyed.

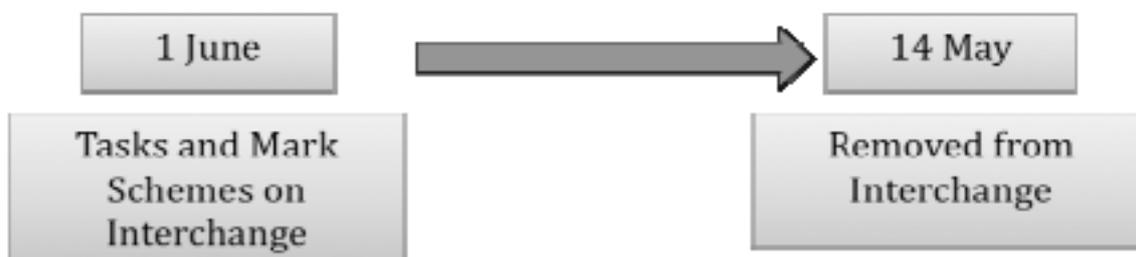
In summary, candidates wishing to improve their F323 mark can re-submit one or two Tasks (from any of the Qualitative, Quantitative or Evaluative Tasks) plus one (or two) of the new available Tasks **OR** complete three new Tasks (from the selection available for assessment on Interchange clearly marked with the current assessment year). If no new Tasks have been attempted (i.e. there is no change in Tasks completed by the candidate) since the previous series then an F323 entry does not need to be made again, any F323 entry in any particular series will stand for the lifetime of the specification in the same way as for theory papers.

Note that students are not permitted to attempt any Task more than once. Where a Task has been issued in a previous series this is clearly indicated on the Instructions for that Task. Only OCR Tasks from Interchange clearly marked with the current assessment year, e.g. 1 June 2009 to 14 May 2010, can be used for practical assessment during that period.

The same guidance applies to A2 Tasks.

Availability of files on Interchange

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



An e-mail alerts service is available. To be notified by e-mail when changes are made to GCE Chemistry A pages 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.

Submission of marks

Centres are encouraged to submit candidate marks for this unit to OCR using Interchange. This greatly accelerates the whole moderation process, allowing centres to receive details of the moderation sample much quicker than by use of handwritten MS1 forms. Teachers may need to consult with the Examinations Officer to gain the relevant access rights.

The AS Tasks

The Tasks proved effective in assessing the ability of the candidates and the marks submitted by the vast majority of centres showed both an accurate interpretation of the Mark Schemes and a good degree of discrimination between candidates. A wide variety of practices exist in centres with some centres completing all of the Tasks whereas others complete only one Task from each Task type. The best approach appears to be those centres where all candidates complete

one Task in each category and then allow candidates to complete a selected number of others to improve their overall score.

AS Qualitative Tasks

The Qualitative Tasks once again proved to be very demanding and although the most able candidates expressed their observations with clarity, many candidates could not use correct terminology such as precipitate and solution or explain that a solid sometimes is seen to dissolve when a reagent is added. All three Tasks performed equally well and were used extensively by centres. Task 2 was the least popular in the work submitted but some very high marks were seen from this Task in the work sampled by Moderators.

Candidates should be made aware through class teaching that it is good practice to carefully shake the test-tube in order to ensure that reagents are fully mixed before recording results.

Centres should 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 and it is unlikely that the results provided cannot be obtained.

However in exceptional circumstances the advice below should be followed (as given in the Practical Skills Handbook).

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. This must be done before the centre embarks on the Task. Advice will be given usually within a few days as to how the centre should proceed.

It is particularly important that measures are taken to prevent stock solutions being contaminated by candidates which could have an effect on other candidates in the centre.

There were a number of issues with the marking of this skill area which require comment and centres should take note of these for future submissions:

- The marking points provided by OCR should be adhered to at all times. Where an answer requires the observation that a yellow precipitate is formed, answers such as '*...it turns yellow...*' should not gain credit. Similarly '*...the solution turns yellow and a solid forms...*' does not communicate the idea that the precipitate is yellow.
- Chemical equations should be balanced and contain state symbols when required.
- Where a marking point requires two distinct observations such as '*...a precipitate forms which turns darker on standing...*', both of these must be present before a mark is awarded. Half marks cannot be accepted.

AS Quantitative Tasks

Many candidates demonstrated proficiency in both the performance of practical skills assessed and in the treatment of the results obtained from their practical work. These three Tasks were used equally by centres to assess this skill area, with no Task being significantly more or less popular than the others. They were equally demanding with Moderators reporting the same mark ranges for each of these Tasks across the sample moderated.

There are a number of points worthy of note for future submissions.

- The Moderators require centre results including masses, titration data and temperatures to be included with the work submitted in order to assess the accuracy of the candidates sampled. Where there is more than one group of candidates it is essential that centres indicate which candidates have been assessed against which values.
- When assessing candidate accuracy it is important to realise that a different mass used by a candidate will give a different temperature change or titre to that of the teacher. In order to facilitate the award of marks for accuracy, a look-up table is provided in the zip file for each Task on Interchange.
- 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. On Interchange, a look-up table is provided in the zip file for each Task to help teachers quickly check calculations. Rounding errors should not be credited at the point where they occur and subsequent answers can be treated as an error carried forward where appropriate.
- When stated in a Mark Scheme, the requirement to give an answer to a specified number of significant figures must be adhered to.

AS Evaluative Tasks

This skill area continues to be the one that provides most discrimination between candidates.

There was a much greater understanding of the errors associated with the different pieces of apparatus this year and it is clear that centres are now routinely teaching error analysis as part of regular classroom teaching.

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

- In some centres, the Mark Schemes were interpreted quite leniently, especially when an answer required two parts. The Mark Schemes are clear and often state that a particular condition is required AND the reason is also given. Marks cannot be awarded for just one of these points.
- Where answers require line graphs or values to lie within certain limits, marks cannot be supported if the value stated is outside the specified limits on the Mark Scheme.
- In the preparation of F323 Evaluative Task 3, some centres awarded marks too leniently for explanations of the changes made to the apparatus in part **(b)**. It is crucial to note that the only answers worthy of credit are those in the Mark Scheme.

F324: Rings, Polymers and Analysis

General comments

This is the first June examination of this unit and the paper produced an excellent spread of marks. The cohort was a mixture of candidates who were sitting this examination for the first time as well as a substantial number of candidates re-sitting following the January exam.

Each of the five questions was accessible to all candidates, but each question contained parts that stretched the most able candidates. The majority of candidates seem to have been well prepared.

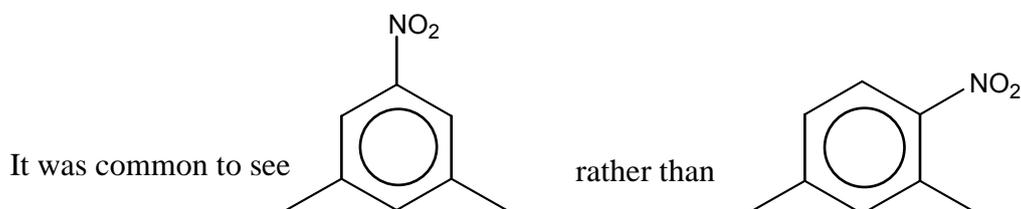
Candidates displayed good examination technique in most of the questions.

Comments on individual questions

Question 1

(a) The Mark Scheme allocated marks for separately explaining benzene's reluctance to undergo addition reactions, the uniformity of the C–C bond lengths and the stability of benzene. There were some very clear concise answers that scored full marks but there was also evidence to suggest that some candidates were not familiar with this part of the specification. A substantial number lost marks whilst trying to explain the stability of benzene which required a comparison of the ΔH hydrogenation values of benzene with those of cyclohexene. Very many candidates incorrectly compared bond enthalpy or boiling points or, most commonly, ΔH hydration.

(b)(i) Compound **A** was often incorrectly drawn with a large majority ignoring the position of the nitration.



Compounds **B** and **C** scored well and were marked consequentially from compound **A**. Compound **D** was well answered but a surprising number either showed two hydroxyl groups or a diazonium compound.

(b)(ii) The electrophilic substitution mechanism was well known and many scored full marks. A substantial number ignored the first line in the stem and simply nitrated benzene.

(b)(iii) This was surprisingly difficult with the most common response being 3. Most candidates seem to have worked out the number of isomers in their head as there was little, or no, evidence of candidates drawing out the different isomers in the space below the question.

Question 2

(a)(i) Candidates had to do a lot of work for the marks, but they did it well. The majority of candidates scored both marks. A common mistake was to have 5 Os in the repeat unit.

(a)(ii) This was designed to be challenging and it proved to be the case. Many seemed to disregard the reactants, a diol and a dioic acid, and simply made up molecules that had the formula $C_{12}H_{14}O_6$. They also made up many molecules that didn't have the formula $C_{12}H_{14}O_6$. Given the reactants (a diol and a dioic acid), the formation of a di-ester should have occurred to more candidates than it did.

(b)(i) The most common incorrect answer was $C_{14}H_{10}O_4$ which is the molecular formula rather than the empirical formula. It was anticipated that many would incorrectly count the hydrogens but a surprising number miscounted the oxygens.

(b)(ii) This was very well answered with the majority of candidates scoring both marks.

(c)(i) This was a challenging question particularly as the information was presented skeletally and required a skeletal formula as the answer. Again there was a lot to do for two marks and only the most able scored both marks.

(c)(ii) This was well answered and the majority of candidates recognised that PGA was degradable.

Question 3

(a) This proved to be the most straightforward part of the paper and very many scored all four marks. It was well answered.

(b) This scored relatively poorly as the Mark Scheme required an absorption within a quoted range and also the identification of the bond responsible for that absorption.

(c) This was well answered by most candidates. The 1H NMR data was presented in an unusual format and it was pleasing to see so many use the data logically and correctly identify the aldehyde. A substantial minority incorrectly concluded that a relative peak area of six equates to six protons in six different environments. Of those that appreciated that there must be two CH_3 groups in the same environment, many then went on to draw a structure with three CH_3 groups with different environments.

(d)(i) This was very straightforward and most correctly identified pentan-3-one.

(d)(ii) Almost all candidates scored between 1 and 3 marks and it is clear that the introduction of ^{13}C NMR in the specification has been well covered by centres.

Question 4

(a)(i) The responses to this were disappointing and the definitions were often very descriptive rather than precise. A simple brief statement that retention time relates to the time from injection to detection would have scored the mark.

(a)(ii) This was generally well answered but again there were some very wordy explanations and a substantial number referred to 'peaks hiding behind each other'.

(a)(iii) This was challenging and exposed poor examination technique by a large number of candidates. $\text{CH}_3(\text{CH}_2)_2\text{COO}(\text{CH}_2)_3\text{CH}_3$ is difficult to name but becomes so much easier if it is drawn out. There was little or no evidence to suggest that candidates did draw out the molecule before attempting to name it.

(b)(i) This topic has been introduced into the new specification, see 4.1.3 (g), and many found deducing the structure from the systematic name difficult.

(b)(ii) This was surprisingly badly answered. It was not uncommon to see ethers, ketones and carboxylic acids rather than the required tri-ester. Again this was a topic added for the new specification, see 4.1.3(f), and many candidates appeared to be unfamiliar with it.

(c) Candidates fell into one of two categories. They either scored well or had no idea where to start and scored badly. The majority fell into the former category and generally marks were lost by carelessly forgetting to include one or more of the reagents, the conditions and the products.

Question 5

(a)(i) This was generally well answered and most candidates identified the chiral centre.

(a)(ii) The production of chiral pharmaceuticals is an old favourite from the *Chains, Rings and Spectroscopy* legacy specification but there have been some additions for the new specification see 4.2.3(e),(f). In terms of the problems faced by the manufacturers the possible adverse effect of isomers was better known than the difficulty/cost of separating or producing one isomer. The chemistry behind the manufacture of a single chiral isomer is complex and candidates are not expected to know any detailed chemistry. To score the marks they simply have to state the methods used by pharmaceutical companies.

(b)(i) This was a very straightforward mark and almost all candidates scored the mark.

(b)(ii) This was the most demanding question in the paper and it was only correctly answered by a very small minority.

(c)(i) It was disappointing that only a small minority of candidates recognised that a salt would be formed.

(c)(ii) Although the chemistry is essentially the same as for **(c)(i)**, it was rare to see $(\text{HOCH}_2\text{CH}_2\text{NH}_3^+)\text{HS}^-$ and even rarer to see $(\text{HOCH}_2\text{CH}_2\text{NH}_3^+)_2\text{S}^{2-}$.

(d)(i) This was surprisingly poorly answered with many vague descriptions about molecules containing an amine group and a carboxyl group. It was also frequent to see amide instead of amine.

(d)(ii) This was also poorly answered: most equations were not balanced and those that were often contained just one [O] which was then counterbalanced by H_2 as a product.

(e) Many candidates struggled to identify **F** and **G**.

F325: Equilibria, Energy and Elements

General comments

This examination must have seemed quite a challenging paper to candidates, ranging over a wide range of topics.

Overall, candidates responded very well to the demands of this paper. It was particularly pleasing to see just how well many candidates rose to this challenge and it was refreshing to mark some very good responses to questions on topics such as reaction kinetics, pH and buffers, equilibria, entropy and transition elements.

Most of the examination was accessible to the average candidate and there was plenty of opportunity for those with flair to display their ability, particularly in the later questions. The paper discriminated extremely well with raw marks ranging from virtually full marks down to zero.

The easiest parts of the paper for most candidates were Questions 1 and 2, assessing knowledge and understanding of the Born–Haber cycle and reaction kinetics (especially analysis of initial rates data). These questions were more predictable than many that followed and had obviously been well-practised by most candidates.

Many found the mathematical problems amongst the easier parts of the paper assessing the application of knowledge and understanding. It was very pleasing to see just how well candidates were able to tackle numerical problems on equilibrium, entropy and free energy, and unstructured titration problems.

Candidates had more difficulty in providing explanations and, in particular, in writing equations. Candidates did particularly poorly with the construction of redox equations in **6(b)** and **7(a)**. Surprisingly few candidates could give a correct ionic equation for the reaction between an acid and a carbonate in **3(e)(ii)**.

Overall, there was no real evidence that time had been an issue in the completion of this paper, with few candidates omitting any questions. Some candidates may have spent too long on earlier parts of the paper and perhaps had to rush later parts. The lesson here is that candidates should pace themselves better throughout the paper, always allowing time to attempt the later questions adequately.

Comments on individual questions

Question 1

This question gave most candidates a gentle introduction to the paper with the majority scoring well over half the available marks.

(a) Almost every candidate got off to a good start with this question with very few being unable to match the enthalpy changes with the correct energy changes in the Born–Haber cycle.

(b) Virtually all candidates made a creditable attempt at calculating the lattice enthalpy with the majority obtaining the correct value of $-2506 \text{ kJ mol}^{-1}$. Where mistakes were made, these inevitably resulted from a failure to notice that 2 mol were involved in the atomisation and first electron affinity of chlorine. This resulted in incorrect responses such as -2705 , -2356 and $-2855 \text{ kJ mol}^{-1}$. These responses were credited with 1 out of the available 2 marks.

(c) This part created some problems for candidates and marks were not awarded for responses that used the wrong particles. The different particles encountered in chemistry have always proven to be a difficult area for many candidates. It was common to see responses such as 'magnesium atoms have a greater charge', 'magnesium chloride has a greater attraction' and 'magnesium ions have a larger atomic radius'. In teaching, the importance of choosing the correct particles at all times cannot be stressed too strongly at all levels.

Question 2

For candidates of all abilities, part **(b)** of this question offered the chance to gather a considerable number of marks. Most candidates scored about three-quarters of the available marks on this question.

(a) In contrast to part **(b)**, this part proved to be very difficult for the majority of candidates. It was common to see equations that were balanced by element but not by charge. The commonest mistake was to see balancing numbers of '2' and '1' for Br^- and Br_2 , respectively, which unfortunately gave different charges on both sides of the equation. The correct balancing numbers for bromine of 5 and 3 were seen comparatively rarely. The best responses obtained the correct balancing numbers by using oxidation numbers.

(b) This question was generally high scoring with virtually all candidates able to construct well-structured responses and to make a creditable attempt at the calculation. In deriving the reaction orders, analysis of the initial rates data proved to be the easier task. Many candidates were not awarded the mark available for analysis of the graph; a response of 'a straight line' was insufficient to justify a first-order relationship as a zero-order graph is also a straight line. Candidates should be encouraged to state that the first-order line goes through the origin, or 0.0. Some candidates chose to ignore the graph entirely. The calculation was well done with many candidates obtaining the correct answer of $0.017 \text{ dm}^9 \text{ mol}^{-3} \text{ s}^{-1}$. If the orders had been derived incorrectly, then the calculation was marked by 'error carried forwards'.

Question 3

Candidates found this question as a whole more challenging than questions 1 and 2, particularly parts **(d)** and **(e)**.

(a) Candidates made a creditable attempt with most being able to suggest that a pH reading would be above that for a strong acid of this concentration. It was also common to see a correct K_a expression. Far fewer candidates showed how the pH value could be converted into $[\text{H}^+(\text{aq})]$ or that $0.100 \text{ mol dm}^{-3}$ should be substituted for the acid concentration in the K_a expression.

(b) This part was very well answered. The opening mark for calculating $[\text{H}^+(\text{aq})]$ was almost always awarded and the majority of candidates went on to gain the second mark for correctly calculating the concentration of the sodium hydroxide solution as 0.29 mol dm^{-3} (although $0.288 \text{ mol dm}^{-3}$ was more commonly seen and was accepted). The commonest mistake was for candidates to conclude that the sodium hydroxide concentration was the same as the $[\text{H}^+(\text{aq})]$. A significant number of candidates approached this problem using pOH and this approach was perfectly acceptable, receiving full credit if correct.

(c) There were some very impressive responses to this part and many candidates had clearly learnt how a buffer solution controls pH. The main difficulty lay in the initial reaction of sodium hydroxide with excess propanoic acid. Only the better candidates realised that this resulted in a mixture of the weak acid and its conjugate base. Some weaker candidates thought that the sodium hydroxide was a component of the buffer solution and it was not uncommon to see responses that described how the hydroxide ions removed added acid. Unfortunately, responses

were too often seen from candidates who had clearly not learnt this important area. Such responses contained made-up chemistry and rarely contained much that could be credited. This was very much a case that poor examination preparation wastes marks, even those for stock questions.

(d) Candidates found this part much more demanding. Many fell into the trap of assuming that propanoic acid was behaving as the acid, producing a propanoate ion and protonating the stronger nitric acid. The labelling of acid–base pairs proved to be the easier task of the two and examiners were able to credit ‘correct’ acid–base pairs from the incorrect protonation. The better candidates responded well to the challenge of this part, collecting both marks.

(e) Part **(i)** proved to be challenging with many candidates forgetting that magnesium forms 2+ ions and producing a salt with the formula $\text{CH}_3\text{CH}_2\text{COOMg}$. Part **(ii)** proved to be very difficult, even for the best candidates. The examiners required a reaction of H^+ ions with CO_3^{2-} ions but many candidates could not cope with selecting the ions that react. As with **(i)**, weaker candidates showed up their poor knowledge of ionic charges and it was common to see NaCO_3 included in this equation.

Question 4

Overall, candidates tackled this question better than question 3 although part **(b)(ii)** proved to be challenging.

(a) Candidates tackled this part extremely well and it was encouraging to see the many correct responses.

Part **(i)** was answered particularly well and most candidates constructed a correct circuit with a correct silver half-cell. The $\text{Fe}^{3+}/\text{Fe}^{2+}$ ion half-cell proved to be more difficult and only the better candidates used a platinum electrode. Weaker candidates often used an electrode made of one of the ions or iron itself.

Parts **(ii)**, **(iii)** and **(iv)** were usually correct, being good mark gatherers for all.

(b) Most candidates successfully chose chlorine as the species in **(i)** but the choice of iodide ions in **(ii)** proved to be much more difficult. In both parts, some candidates seemed unaware of what a ‘species’ was and instead showed the half-equation.

(c) The part was relatively undemanding but success was largely dependent on whether the specification material had been learnt. There were some very impressive responses but, as with **3(c)**, it was disappointing to see many candidates making up their responses and wasting marks.

Question 5

Overall, this question was tackled well and there were some impressive responses to the new areas in the specification.

(a) This part was amongst the easiest on the paper with nearly all candidates collecting the marks for both the K_c expression and the units.

(b) Most candidates were able to gain some credit for their attempts to this part. Many candidates though did not initially convert the moles in the question to concentrations, in mol dm^{-3} , required by the K_c expression. The most difficult part to this calculation involved the square root of a complex expression, itself containing $[\text{H}_2]^3$. Calculator skills let down some candidates

while others dropped the power from H_2 altogether or transcribed it incorrectly to squared. Others did not take a square root and then, after obtaining the concentration, failed to multiply this by 6 to find the equilibrium amount of ammonia. The better candidates handled this part with confidence and seemed to obtain the correct answer of 5.26 mol and all 4 marks with comparative ease.

(c) Candidates found part **(i)** easy as a simple application of Le Chatelier's principle met during AS Chemistry.

Part **(ii)** proved to be extremely challenging and was designed to stretch and challenge the very best candidates. Many candidates correctly stated that K_c would not change but then went on to describe a change in K_c in their explanation. The subtlety required was that the increased pressure changes all concentrations, moving the system out of equilibrium (as there is a different total number of gaseous moles on either side of the equilibrium). As there are more concentration terms on the bottom of the expression (the reactants), these must decrease whilst those on the top of the expression (the products) increase until equilibrium is established once more, when K_c is reached. Only the very best candidates could explain this.

(d) Candidates coped with **(i)** very well and any correctly balanced equation was acceptable provided that hydrogen was one of the products and that any other products were real compounds. Surprisingly, candidates struggled with **(ii)**. The commonest correct response seen was the electrolysis of water.

(e) The question assessed entropy and free energy, areas of chemistry new to this specification. Part **(i)** was answered extremely well with the majority of candidates scoring more than half of the available marks.

Mistakes were sometimes made for the following reasons. The first stage of the calculation required the entropy change to be determined. Weaker candidates often did not multiply the entropy values by the balancing numbers of each species in the equation. In the determination of the free energy change, some candidates did not convert 25 °C to 298 K and others did not convert their entropy change into kJ from J. Most candidates realised that a feasible reaction requires ΔG to be negative. The correct calculated answer was $-32.4 \text{ kJ mol}^{-1}$ or $-32\,400 \text{ J mol}^{-1}$.

Bearing in mind that entropy was being assessed for the first time and in an unstructured format, the responses seen were very impressive.

Part **(ii)** caused more problems with weaker candidates being unsure of what was required. Better candidates realised that $T\Delta S$ would become more significant as temperature increased. As ΔS was negative, the point would be reached at which the reaction became non feasible with $T\Delta S$ becoming more significant than ΔH and ΔG becoming positive.

Candidates answered part **(iii)** with ease in terms of the increased rate of reaction required.

Question 6

Candidates coped well with most aspects of this question and were able to apply their knowledge and understanding of transition metals to the chemistry of chromium in the question. The hardest part was the novel problem set in the final part of this question.

(a) Candidates certainly knew what was required in this part but many got muddled with the electron configuration of a Cr atom. It should be remembered that a Cr atom has a half-full 3d sub-shell rather than a full 4s sub-shell. Candidates more successfully gave the electron configuration of a Cr^{3+} ion which did not include the 4s sub-shell.

(b) Candidates find the construction of redox equations difficult. Even the straightforward zinc half-equation was often left with just one electron and the balancing the chromium half-equation was beyond all but the better candidates. Consequently the correct overall equation was seen comparatively rarely, except by the very best candidates.

(c) Candidates found **(i)** very straightforward and many were able to then apply their knowledge of ligand substitution to the novel example in **(ii)**. A sizable proportion of candidates were able to construct a correct equation forming $[\text{Cr}(\text{NH}_3)_6]^{3+}$ complex ions. There were many equations seen which showed formation of $[\text{Cr}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{3+}$ by analogy with Cu^{2+} and such responses were awarded 1 mark if 'correctly' balanced.

(d) All parts were answered well.

In **(i)**, it should be noted that the examiners required the role of a metal ion to accept an electron pair in the formation of a coordinate bond.

In **(ii)**, the examiners were expecting to see both two coordinate bonds and identification that these could be formed from the oxygen and nitrogen atoms in the ligand.

In **(iii)**, the standard of the diagrams seen was very impressive with most candidates drawing the required 3-D representations of the optical isomers. Candidates should be congratulated for their ability to apply the chemistry encountered in the course to this situation.

(e) This unstructured problem assessed a range of skills from a simple empirical formula calculation to identification of ions, products and writing an unfamiliar equation. Most candidates were able to derive the empirical formula but the weaker candidates rarely got further. Better candidates usually made some headway and commonly identified **B** as Cr_2O_3 and **C** as N_2 . The best were able to complete all parts to secure all marks. The hardest part of the problem was the identification of the NH_4^+ and $\text{Cr}_2\text{O}_7^{2-}$ ions present.

Question 7

Although this was the last question in a long examination, the vast majority of candidates attempted both parts to some credit.

(a) As with other areas in the paper, construction of this redox half-equation caused problems for most candidates. Significantly, many finished up with the electrons on the wrong side of the equation.

(b) Most candidates were able to make some headway with this problem, especially in determining the amounts of MnO_4^- and H_2O_2 used in the titration. Candidates started to struggle with the subsequent stages involving scaling and many muddled their powers of ten. There were some creditable attempts to find the volume of oxygen although there were similar problems with powers of ten. The correct calculated answers were 15.9 mol dm^{-3} for the concentration of H_2O_2 and 0.0281 dm^3 (or 28.1 cm^3) for the volume of oxygen.

F326: Practical Skills in Chemistry 2

General comments

Most centres used the experience gained last year through the AS Tasks to approach the assessment of the A2 Tasks with confidence. The majority of the work received had been marked carefully in accordance with the Mark Scheme and it is to the credit of teachers that they show such a high degree of professional care.

Only a small proportion of the marks submitted were adjusted as a result of the moderation process. Most of these stemmed from the wish of centres to interpret the Mark Schemes too flexibly or to give their candidates the benefit of the doubt on occasions where it was scarcely warranted. Centres must realise the importance of a rigorous adherence to the Mark Scheme and it is emphasised that very little leeway should be allowed in the responses that can be accepted. Occasionally, particularly within the Evaluative Tasks, a certain measure of judgement may be required to account for differences in the way candidates phrase their responses but a wholly different approach cannot be allowed.

Administration

Centres are directed to the useful administrative comments included in the report for F323 (Practical Skills in Chemistry 1), the practical skills assessment model at A2 is identical to that at AS and these comments are equally valid for both units.

The A2 Tasks

No doubt under the pressure of completing the other units, many centres opted to use just one Task in each category to assess the practical skills of their candidates. However, a number of other centres did make use of all nine Tasks. Although some Tasks proved more popular than others, all of them were represented in the work received.

Although the Tasks were usually marked reliably, some centres did not make it clear how the marks had been obtained. It would assist the Moderators if, where a mark is awarded, the response is ticked and the mark put in the margin. This is preferred to the mark simply being ringed on the paper.

A general marking point that was not always appreciated is that candidates cannot be allowed to contradict themselves in providing a response or suggest two possible answers where only one is correct. For example, if the answer required is '*...stays constant...*' the mark should not be awarded for '*...generally stays constant but may go down a bit...*'.

A2 Qualitative Tasks

The Qualitative Task usually represented the best mark in percentage terms achieved by a candidate although the more able perhaps performed better in the Quantitative Task. This might be expected as little more than careful observation and accurate recording is required. However, many candidates do clearly find this more demanding than might be thought.

The correct word should be used to describe a particular observation. An example would be the appropriate use of the word 'precipitate' to describe the formation of a solid when two solutions are mixed and the word 'liquid' should not be used as an alternative to 'solution'.

Colours are to a certain extent subjective and this is recognised in the Mark Schemes by allowing a reasonable range of alternatives. However, this range must not be extended so that virtually anything is allowed. Nor should candidates who combine multiple colours in an attempt to gain a mark be given credit. A response such as 'yellowy–greenish–blue' is hedging their bet too far.

On a few occasions one mark is awarded for two observations. This is potentially a source of error and centres are asked to take particular care to check that both observations have been recorded and that only one mark is then given.

Centres should carry out Tasks in advance to ensure that the solutions used are made up in accordance with the instructions given and that their results are in accordance with those provided on the Mark Schemes. All Tasks have been extensively trialled and the observations expected have been confirmed independently. If a centre has difficulty in reproducing the expected results the Practical Skills Handbook gives guidance on what to do. It has been noted that this situation often tends to occur as a result of substances or solutions deteriorating as a result of storage and wherever possible this should be avoided.

A2 Quantitative Tasks

On the whole, candidates showed a good degree of competence in carrying out the Quantitative Tasks and many interpreted their results accurately.

However the presentation and recording of the data was often surprisingly poor. The importance of quoting results to a consistent number of significant figures seemed to be lost on some candidates even when the required precision was clearly quoted within the Task instructions. There were also many simple mistakes in subtracting numbers and in processing the results that had not always been spotted by teachers. The use of the OCR look-up tables available on Interchange might have helped limit errors in this area.

Another issue was the accuracy of graphs. Many candidates failed to plot points correctly and, even when they did, found it very difficult to draw a convincing line of best fit. It was felt that teachers interpreted this aspect of the Mark Scheme too liberally.

The importance of supplying centre values cannot be over-emphasised. The work cannot be moderated unless these are available. In the case of multiple sets it is usually necessary to provide more than one set of data and it would be a great help if, in these circumstances, the relevant information was written onto any script sent for moderation.

When assessing the accuracy of candidate results, it may be necessary to adjust the centre results to take account of any ways that the candidate experiment might have differed from the supervisors. For example, if a different mass was used to make up a solution this might affect any subsequent measurements that are made.

A2 Evaluative Tasks

The Evaluative Task is the hardest part of the assessment of practical skills for all but the most able candidates. This is understandable because the questions asked delve deeper than in the two other parts of the assessment. Some of the parts are deliberately designed to be challenging and to test whether candidates can provide a reasoned answer to an unfamiliar situation.

The easiest parts proved to be those that involved a numerical calculation and the hardest those that required a clear understanding of the procedures involved. It is in these areas that the Mark Scheme sometimes required teachers to make a judgement as to whether or not an explanation was sufficient to warrant the award of a mark. Where the answer given was anchored firmly to

Reports on the Units taken in June 2010

the guidance given in the Mark Scheme, the Moderators were prepared to accept the centre's decision but, unfortunately, this was not always the case. Teachers must be careful to make sure that they have understood the Mark Scheme before they give a candidate the benefit of the doubt.

Care must also be taken to refer closely to the Mark Scheme with respect to significant figures. Often considerable flexibility is allowed in the answers that can be accepted but this does not always apply and the Mark Scheme instructions should be followed exactly.

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