



GCE EXAMINERS' REPORTS

**CHEMISTRY
AS/Advanced**

SUMMER 2015

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CHEMISTRY
General Certificate of Education
Summer 2015
Advanced Subsidiary/Advanced
CH1

Principal Examiner: Mr Elfed Charles

General Comments

This was the last paper for year 12 students for this specification. 3728 candidates sat the paper with just under a quarter repeating the unit. 345 sat through the medium of Welsh. It was felt that the paper offered an opportunity for all candidates to show positive achievement and this was reflected by the small number of marks below 25. The mean mark was 49.1.

In Section B the most successfully answered question as a whole was Q.5 with Q.9 being the least successfully answered. The easiest parts on the entire paper proved to be Q.5(a), Q.5(b)(ii) and Q.1, while the hardest parts were Q.9(b)(i), Q.7(a)(iii) and Q.8(b)(ii) in that order.

It was pleasing to note that good knowledge of electronic configuration, energy profiles, equilibrium, the mass spectrometer and radioactivity was shown by a significant number of candidates. It was also good to see that almost all were very knowledgeable in 'green chemistry'.

As in previous papers the examiners noted that many candidates did not read the questions carefully enough and did not give specific answers to the actual question. Once again for some candidates, answers that required detailed responses often lacked depth of content and were sometimes contradictory.

The recent trend in performing well in the calculation questions seems to have halted. This could be because some of these calculations were slightly different and candidates' understanding of numerical concepts are lacking in depth. In light of the mathematical content in the new specification this gives cause for concern.

Atebion Cyfrwng Cymraeg

Safodd ychydig dros 9% o'r ymgeiswyr y papur trwy gyfrwng y Gymraeg. Ar y cyfan roedd safon yr atebion ychydig yn wanach na'r rhai drwy gyfrwng y Saesneg yn enwedig yn y cwestiynau mathemategol. Mi roedd y mwyafrif o atebion anghywir yn dilyn yr un patrwm a'r canolfannau Saesneg.

Roedd ymgeiswyr yn defnyddio'r termau Cymraeg yn hyderus mewn gwaith estynedig a gwelwyd iaith raenus mewn llawer o'r atebion hirach, fel sbectwm atomig hydrogen. Nid oedd iaith y cwestiynau wedi achosi unrhyw anhawster i'r ymgeiswyr, heblaw am y rhai gwanaf. Diffyg gwybodaeth a dealltwriaeth oedd yn debygol o fod y rheswm dros golli marciau ac nid yr iaith a ddefnyddiwyd ar y papurau.

Section A

Candidates generally scored well in this section, with the average mark being around 6.5 out of 10.

- Q.1** Almost all candidates knew the number of protons, neutrons and electrons in the given atom. The vast majority of candidates knew the number of protons, neutrons and electrons in the given ion.
- Q.2**
- (a) Around four-fifths gave the correct mass number and symbol.
 - (b) Again, over four-fifths understood what half-life meant.
 - (c) Very well answered. The vast majority could calculate the mass of radium remaining and around two-thirds correctly calculated the moles remaining.
- Q.3**
- (a) Poorly answered. Fewer than one in five candidates understood the meaning of molar mass. Most candidates referred to ^{12}C and so lost the mark.
 - (b) This simple enthalpy calculation using Hess's Law was fairly well answered with around three-fifths of candidates gaining the mark.
- Q.4**
- (a) This was fairly well answered with around half giving a correct method. The most common error was a failure to make any reference to time which is essential in measuring any reaction rate.
 - (b) Poorly answered. Most candidates thought that the reaction rate increased. Fewer than one in five candidates realised that since the concentration did not change the rate would not change.

Section B

Q.5 This question was the most successfully answered question in this section.

- (a) This proved to be the best-answered question on the whole paper. Only a small number failed to obtain both marks.
- (b) In part (i) about three-quarters gave the correct empirical formula of N_2O_5 . A common error was to round up the ratio of 1:2.5 to 1:3 giving an incorrect formula of NO_3 .

The vast majority could balance the equation in part (ii).

Part (iii) involved a molar volume calculation and this proved to be more of a problem. Only about one-fifth of candidates managed to obtain all three marks and around a quarter failed to score any marks.

- (c) This calculation, where candidates had to find the value of x in a hydrated salt formula, was better answered. Around a third obtained the full three marks but again about a quarter of candidates failed to score a mark.

Q.6 (a) In part (i) about two-thirds of the candidates knew the definition for molar first ionisation energy, however a significant number lost a mark for omitting 'gaseous state' or '1 mole' or stating 'element' instead of 'atom'.

Most candidates knew that aluminium's first ionisation energy lies between that of sodium and magnesium in part (ii).

Part (iii) was poorly answered with around half the candidates failing to score any marks. Some managed to gain a mark for explaining the idea of electron pair repulsion within the p -orbital of sulfur's outer shell. However far too many answers were too vague about the location of the paired electrons or did not mention phosphorus at all.

- (b) This was about successive ionisation energies and part (i) was poorly answered. Only about a quarter of candidates could successfully explain why magnesium's second ionisation energy is greater than its first. Maybe due to the previous question most candidates tried to explain in terms of electron pair repulsion.

Part (ii) was better answered with about two-thirds realising that as magnesium is in Group 2 there will be a large jump between the second and third ionisation energies.

- (c) This part was about the emission spectrum of hydrogen and on the whole it was well answered, with about three-quarters gaining at least three marks out of five. The vast majority scored at least two marks out of three in explaining how these lines arise in the visible region. The most common error was to omit that visible light is emitted when an electron falls from higher energy levels to the $n = 2$ level. Some candidates also lost a mark for failing to adequately explain why the lines become closer together.

Q.7 (a) The first two parts about the mass spectrum were well answered.

In part (i) over two-thirds correctly explained how atoms are converted to ions and gained both marks.

In part (ii) over half the candidates could explain why a minimum energy is used to create the ion.

Part (iii) was about the properties of isotopes and was very poorly answered. Surprisingly only about a quarter of candidates could state that there is no difference in the chemical properties of isotopes and only a small minority could explain why.

(b) Well answered. The vast majority could calculate the relative atomic mass of the sample and most could explain which ion was deflected more.

(c) The first part was generally well answered. Most candidates managed to calculate the moles of ammonium sulfate and gain both marks. A significant number, however, lost a mark for incorrectly calculating the molecular mass or failing to give the answer to three significant figures as requested.

The second part was also well answered with about three-fifths correctly calculating the concentration of lithium hydroxide. The main error was failing to use the ratio in the equation.

The third part, calculating the atom economy, was not as well-answered. Only just over a third scored both marks. The main errors were not using two moles of ammonia and incorrectly calculating the molecular mass of ammonium sulfate.

Q.8 (a) This part was about reducing the use of fossil fuels, increasing the use of renewable energy and improving energy efficiency. It was generally well answered with around three-quarters obtaining at least three marks and about a third obtaining four or five marks out of five. Candidates clearly understand the benefits of reducing fossil fuel use and the difficulties associated with renewable energy. However, some simply listed types of renewable energy while others, as in previous years, wrote about ozone layer depletion.

(b) (i) The vast majority could interpret the graph and gained the first mark. As with part (a), the second part was generally well answered with around three-quarters obtaining at least three marks and about a third obtaining four or five marks out of five. Candidates clearly understand how temperature and the difference in the number of moles of gas between the reactants and products influence equilibrium.

(ii) This proved to be very tricky to answer and only a small number of candidates managed to give two reasons. A minority scored one mark by explaining in terms of a compromise temperature between yield and rate. However, the vast majority either did not know the answer or they failed to express themselves clearly enough and did not gain a mark.

- (iii) The vast majority knew the type of catalyst used.
- (iv) Generally well answered. Most candidates could explain why better catalysts are needed in industry. Those that simply stated the definition of a catalyst did not gain a mark.
- (v) Very well answered with around three-quarters gaining both marks, showing that energy profiles are well known.
- (vi) Surprisingly, less than half the candidates knew that for a reversible reaction $\Delta H = E_f - E_b$.

Q.9 This was the least well answered question in this section. The question was based on an experiment to find the molar enthalpy change of a neutralisation reaction.

- (a) Poorly answered. Only around one-fifth of candidates scored the mark. A failure to express themselves clearly enough was the main cause of losing the mark.
- (b) Only a very small number of candidates realised that the first best fit line was a curve. Many ignored the first point and so got an incorrect value for ΔT . However, around four-fifths, gave a correct answer for part (ii).
- (c) Generally well answered with around half gaining both marks for calculating the concentration of the acid.
- (d) Poorly answered. Many candidates knew that they had to use the expression 'mass x 4.18 x temperature change' but most did not use the correct mass. Only about a quarter realised that the volume of alkali needed to be added to the volume of acid to obtain the correct mass.
- (e) Again poorly answered with only about a quarter gaining both marks. The main errors were to omit the negative sign and fail to convert to kJ mol^{-1} .
- (f) Very well answered. The vast majority chose an appropriate piece of apparatus to measure the solution.
- (g) Fairly well answered. Most candidates knew that no further reaction occurs after the alkali has been neutralised, however only a small number could state that the excess acid cooled the solution.
- (h) The reason for the low value in the experimental result was very well known. A significant number lost a mark because they were not specific enough in explaining their method to prevent heat loss.

CHEMISTRY
General Certificate of Education
Summer 2015
Advanced Subsidiary/Advanced
CH2

Principal Examiner: Ms Kathryn Foster

General Comments

The paper proved generally accessible and all questions were attempted in almost all scripts it did not appear that lack of time was a significant factor in candidates' performance.

It was evident that most candidates had prepared well so that questions set in a familiar form were generally well answered. Questions that were set to discriminate at the higher levels of achievement generally succeeded in this aim. This meant that the most able were given the opportunity to show real understanding of the material and a significant number rose to this challenge. These questions tended to be those set in unfamiliar contexts – qualitative or numerically based. Examples are given below.

Section A

1. Most candidates gave a correct electronic structure with only a small number interpreting the effect of creating an ion incorrectly.
2. Marks were awarded for the correct numbers of electrons and charges in the **final** structure. A number drew the initial atoms with arrows on some of the electrons but never actually drew calcium fluoride.
3. It was evident that many candidates had learnt an acceptable definition.
4. Although many correct structures were drawn, a number used chlorine as a label, drew uncharged atoms in the structure or apparently drew a face centred cubic arrangement.
5. Apart from a few names with the oxidation state of chromium incorrect or written in the wrong place (e.g. potassium(VI) dichromate) this was well answered.
6. A few candidates omitted the number for the alkene group but many correct names were given.
7. A small number of candidates apparently were unable to write the formulae of alkenes but many correct equations were given.
8. Some candidates still find drawing the polymer from a branched-chain alkene difficult but many correct structures were seen. Candidates should be advised to be careful how they attach side chains since $\text{—CH}_3\text{CH}_2$ was not accepted.

Section B

9. (a) (i) It was evident that most candidates had seen the reactions with water but the question did ask for the observation to show the difference. This meant that a comparison between sodium and potassium was needed.
- (ii) The increase in reactivity as the group is descended was generally known but, to score the explanation mark, a comment on increase in atomic size or electron shielding was necessary.
- (iii) A comment on how easily the outer/valence electron was lost was required.
- (b) (i) This is an example of a question that proved challenging for weaker candidates. The instruction to 'state **one** factor' meant that differences in electronegativity had to be discussed rather than vague statements about the position of elements in the Periodic Table.
- (ii) Only able candidates recognised that the question asked for a description of *electron density* and not of what happens to electrons as different types of bonds are formed.
- (c) Most candidates correctly identified the metal involved but, even if an incorrect one was chosen, they were credited with the correct responses for that metal. Only the ionic equation was poorly answered with many answers omitting the '2' needed in the formula of the hydroxide and to balance the equation.
10. (a) Many acceptable answers were seen but responses involving a *p*- shell or an element having electrons in a *p*- sub-shell were not credited.
- (b) (i) To be given the mark candidates were required to differentiate between the three 'normal' covalent bonds and the co-ordinate bond.
- (ii) Many candidates quoted the correct bond angle but far fewer discussed the reason in terms of repulsion between pairs of electrons.
- (iii) Nearly all candidates correctly balanced the equation.
- (c) (i) Most candidates were clearly familiar with oxidation numbers.
- (ii) Most candidates showed they understood the principles involved but a number ignored the need to use the '2' from the balanced equation.
- (d) A significant number of candidates correctly gave an answer of 17 g but 34 g and 48 g were also often quoted.

11. (a) (i) Most candidates were clearly familiar with curly arrow mechanisms but marks were not awarded if arrows started and finished inappropriately. Candidates should be aware that, for example, that if a bond is being broken the arrow must start on the bond.
- (ii) Both nucleophilic and substitution were required.
- (iii) Most candidates described the significance of heterolytic but fewer included the significance of fission.
- (b) (i) Apart from some confusion between aqueous and alcoholic this was known.
- (ii) Elimination was known by nearly all candidates.
- (iii) Most candidates drew butene but many ignored the word **structural** in the question and drew E/Z isomers.
- (c) Most candidates recognised the significance of hydrocarbon chain length and hydrogen bonding in this context and some well-expressed answers were seen.
12. (a) A small number of responses were seen based on aluminium and/or sodium having ionic/covalent bonds but most described metallic bonding. For full credit it was necessary to include reference to both metals.
- (b) Most candidates realised that iodine is brown but for full credit it was necessary to explain why the reaction occurred rather than just stating that it was a displacement reaction.
- (c) This was an example where perhaps an unfamiliar context caused many candidates not actually to address the question set. A significant number therefore answered in terms of forming hydrogen bonds with water and thus why ammonia is soluble in water, rather than why it has a comparatively high boiling temperature.
- (d) Most candidates stated that the mechanism was radical based and many were able to name a product other than chloromethane. Very few considered polychlorination so that most correct answers were based on the formation of ethane.
13. (a) This question again differentiated well since able candidates were able to interpret the data in the question whilst weaker ones appeared confused. This was seen when, for example, the 1.20 g of acid and 1.79 g of carbon dioxide were reversed or used inappropriately. Most knew how to find an empirical formula and credit was given for this stage even if the masses of the elements calculated were incorrect. In part (v) the test for unsaturation was generally known but in part (vi) many structures drawn only contained one —OH group.
- (b) Most gave acceptable answers involving the molecular ion, parent ion or M_r in part (i). Parts (ii) and (ii) were well answered.
- (c) Although it was clear that most candidates were familiar with the conversions shown, a significant number stated a suitable catalyst for ethene to ethanol but did not include steam.

CHEMISTRY
General Certificate of Education
Summer 2015
Advanced Subsidiary/Advanced
CH3

Principal Examiner: Dr Peter Blake

This is the last report on the CH3 unit which is being pensioned off after more than a decade of noble service during which over twenty thousand students have undergone and hopefully enjoyed their coursework.

Practical work will continue to play an important role for the new specification but in a different arrangement. Specified practical tasks will be carried out by all candidates, and practical-related questions will continue to appear in theory papers, but the laboratory work will not be assessed at AS.

Since the unit has ended there is no point in discussing administrative details and the report will focus on the way in which the current experiments relate to the practical and mathematical requirements of the new specification.

Thermochemistry 3.1 A-D

The important skills here are weighing and graphical analysis. Weighing errors cannot be corrected. The mass transferred must be within the allowed range and accurately recorded to the full number of significant figures offered by the balance.

Graphs must be clearly titled, axes labelled and be drawn using as large a scale as possible to maximise sensitivity. Extrapolation back to the point of mixing requires some judgement and it is easy to make an error in measuring ΔT . General techniques such as stirring and adequate insulation come into play. Mathematically, care is needed in scaling up to molar amounts, watching the signs (since most ΔH values are exothermic) and stating the final result to a sensible number of significant figures – probably about three for an experiment with an error in the region 5%. To write down the complete calculator output is absurd and shows a lack of understanding of the whole process. On the other hand over-truncation of a result, such as returning a value of 0.96 as 0.9, or even 1.0, destroys data of significance produced by the experiment.

Kinetics 3.2A-B

These two interesting experiments usually give very satisfactory results and are encouraging for students' confidence. Choosing and making up mixtures and timing the runs cause little difficulty. The general points about graphs are dealt with above; however certainty and precision in the results is increased if the concentration ranges used are maximised. As in all kinetic work temperature is the main variable and with an increase in rate of around 6% per °C more precise rates are unlikely to be achieved in un-thermostated conditions.

Acid-Base Titrations 3.3 A-C

Here the skilful manipulation of burettes, volumetric flasks and pipettes and a reliable and careful titration method are the key to consistent and good results. It is here that one sees the greatest range of skill in candidates' ability to control the burette tap and judge the approach of the endpoint. Adequate practice is essential. Mathematically, judgement is needed as to which burette readings are acceptable to calculate a mean value and to estimate its uncertainty.

Conclusion

The new specification system may give a fresher and freer approach to AS practical work and it is hoped that teachers' experience in the current system will help them in the future.

CHEMISTRY
General Certificate of Education
Summer 2015
Advanced
CH4

Principal Examiner: Dr David Ballard

General Comments

This paper seemed similar in performance to the corresponding paper in June 2014. As last summer there were fewer papers with lower marks and a number of excellent scripts were seen. There was clear evidence of good preparation for the examination.

The comprehension section about ethynes showed that many candidates could extend their knowledge about unsaturated compounds to those that contained triple bonds. As in previous CH4 papers there were relatively few questions that needed numerical answers and these were generally well answered. Some candidates continue to be careless in writing structures for organic molecules; bonds must link the correct atoms. There were fewer papers that simply showed 'sticks' without being attached to atoms at all.

The examining team feel that some candidates continue to lack skills in presentation and legibility and that attention should be paid to this aspect of their 'A' level and future work. The examiners thought that candidates had been given the opportunity to show what they had learnt and then to apply their knowledge in new situations.

There was some evidence of a few candidates having to rush questions in Section B.

Atebion Cyfrwng Cymraeg

Roedd atebion cyfrwng Cymraeg yn debyg iawn i'r rhai Saesneg, gyda'r un cryfderau a gwendidau. Defnyddiodd mwyafrif helaeth yr ymgeiswyr dermau gwyddonol Cymraeg yn fanwl gywir ac yn rhugl. Dim ond nifer bach iawn oedd yn troi i'r gair Saesneg nawr ac yn y man.

Dylai ymgeiswyr gymryd gofal wrth ysgrifennu hafaliadau cemegol. Fe gollodd nifer ohonynt farciau am ddefnyddio fformiwla moleciwlaidd yn lle un strwythurol sy'n ddiamwys (e.e. yn rhoi $C_2H_4Br_2$ yn lle CH_2BrCH_2Br yng nghwestiwn 3(ch) neu roi $C_3H_7NH_2$ sy'n anghywir yng nghwestiwn 5 (a)). Hefyd, mae rhaid cofio cydbwyso'r hafaliad, (e.e. rhoi HCl ar y dde yng nghwestiwn 1(b) a rhoi H_2O ar y dde yn 5(ch)(i)). Roedd amrywiaeth rhwng canolfannau yn safon atebion lle defnyddir NMR, ond ar y cyfan roedd yr ymgeiswyr wedi dangos dealltwriaeth dda o wahanol destunau.

Section A

- Q.1** (a) This was meant to be any easy starter question that asked candidates to relate colour, frequency and wavelength in an aromatic system. Most candidates gained all three marks but there was some evidence of weak candidates merely guessing from the range of words given.
- (b) (i) The question asked candidates to give the equation for this Friedel-Crafts reaction. A number omitted the other product of the reaction, hydrogen chloride. A few gave the mechanism, which was not required.
- (ii) The majority showed good knowledge of the role of the catalyst in this reaction, although some wrote about activation energy even though the stem of the question said 'apart from increasing the rate'.
- (c) Most candidates gained both marks for this question about the NMR spectrum of 1,4-dimethylbenzene. A few candidates did not give a clear response and lost a mark as a consequence.
- (d) (i) The question clearly said that 1,4-di(chloromethyl)benzene was a liquid. Despite this, many candidates thought that a measure of the melting temperature was an appropriate way to test for its purity. TLC and paper chromatography were sometimes seen and also gained no credit. The examiners felt that (fractional) distillation was an inappropriate method although an examination of the boiling points might show if the material was impure. The expected responses, NMR and GLC were frequently seen but some candidates struggled to find two correct answers.
- (ii) Most candidates gave the formula of the -diol correctly.
- (e) (i) A number of candidates did not realise that this was a different amine to the one usually encountered and, as a result missed out the two —CH_2 groups between the ring and the —NH groups. Some candidates did not make it absolutely clear which was the repeating section and this is a point that needs more emphasis. The examiners would prefer the peptide linkage written out to show all its bonds rather than the —CONH— that was sometimes seen.
- (ii) The question asked for a naturally occurring material that contained a peptide linkage. Surprisingly nylon and Kevlar[®] were frequently given as answers. Some candidates simply wrote 'amino acid' and did not gain a mark.
- Q.2** (a) (i) Most candidates correctly gave sodium cyanide or potassium cyanide. A number however, gave hydrogen cyanide, which gained no credit.
- (ii) Many candidates lost a mark here by providing the formula of ethanoic acid, rather than the required ethanoyl chloride. Only a few gave ethanoic anhydride, which was also acceptable.
- (iii) This was generally correct. Most candidates gave sulfuric acid or hydrochloric acid.
- (iv) The zwitterion was generally drawn correctly. The examiners thought that the positive charge should reside on the nitrogen atom and not in an indeterminate place.

- (v) This question provided for a number of acceptable answers. It was necessary for the provided structure to not violate valency codes and to have an aldehyde functional group. Some interesting correct structures were seen that would be very difficult to synthesise given their apparent instability!
 - (vi) Lithium tetrahydridoaluminate(III) was generally provided as the correct answer.
 - (vii) A number of candidates failed to mention that it was the nitrogen atom of the amine group that acted as the base by providing a pair of electrons or by acting as a proton acceptor.
- (b) Many excellent answers were seen to this question, as candidates worked logically through each stage to come up with either of the two correct answers.
- (i) The vast majority of candidates used the information correctly and gave the molecular formula as $C_4H_4O_2$ and the number of carbon atoms in the ring as 3 in the answer to part (ii).
 - (iii) The alkene group was usually correct.
 - (iv) A clear explanation of the NMR data was given by most candidates.
 - (v) Most candidates gave one of the possible formulae for the very toxic unsaturated alicyclic carboxylic acid.

- Q.3** (a) The examiners expected all the bonds to be shown in the displayed formula of pent-2-yne. Most candidates showed every bond but a few provided the formula of a different compound, often pent-1-yne or propyne.
- (b) Many candidates used the information correctly and obtained the expected answer of 187 dm^3 .
- (c) This question was too often inadequately answered. Many candidates simply repeated the question stem rather than emphasising that the high temperature had an effect on the position of equilibrium.
- (d) Too many candidates did not clearly indicate the formula of 1,2-dibromoethane, instead just writing $C_2H_4Br_2$. A number of equations were unbalanced.
- (e) A significant number of candidates showed a weakness in their understanding of organic reaction mechanisms. Curly arrows were often started from electrophiles and ended in vague places. The full charges for the bromide ion and the carbocation were frequently omitted.
- (f) There were many acceptable answers to this question but candidates should beware of giving simplistic answers such as 'cost' and 'waste'. In general a measure of detail should be provided to obtain credit.
- (g) Although a number of good answers were seen for the displayed formula for the alkyne, too many candidates misunderstood the meaning of the term 'empirical formula' and lost an easy mark as a consequence.
- (h) (i) Most responses were given correctly. It is important to emphasise clearly the repeating unit.

- (ii) I Nearly all candidates suggested (concentrated) sulfuric acid as their correct response.
- II It was important in this question to mention that the absorption at 1620-1670 cm^{-1} due to the alkene linkage was present in propenoic acid but not in 3-hydroxypropanoic acid. Some candidates stated that the absorption due to the —OH group was present in the hydroxyacid but not in the unsaturated acid, presumably forgetting that the carboxylic acid also contained an —OH group.
- III Although many good answers were seen for the structure necessary for a positive triiodomethane reaction, there were a number of vague answers given without justification, for example, it is not a secondary alcohol.

Section B

- Q.4 (a)**
- (i) This was often answered poorly. A number of candidates could give one reason why the compound shown was not the only probable structure but could not give another one.
 - (ii) Most candidates gave another structure for the addition of hydrogen chloride across the double bond but very few realised that the intermediate carbocations were both secondary giving an equal chance of both isomers being formed.
 - (iii) Although potassium dichromate(VI) was given as the oxidising agent, a number still failed to mention that it needs to be acidified and lost credit as a result.
 - (iv) A precise answer was needed in this question about chirality. Too often 'polarised light was rotated' (rather than its plane) and the descriptions of racemic mixtures were not clear.
 - (v) Some candidates wrongly believed that sodium tetrahydridoborate(III) would reduce a carboxylic acid. Many candidates failed to give the correct number of carbon atoms in the side chain of their reduction product.
- (b)
- (i) Nearly all candidates mentioned that effervescence was seen and that this identified the presence of a carboxylic acid. Only a few candidates persisted in trying to obtain credit by writing that carbon dioxide is evolved.
 - (ii) A number of responses showed that the candidates knew the basic idea being tested but could not express it clearly. To write that the chlorine or its electrons become incorporated into the bond is clearly wrong. It was necessary to include a comparison in referring to the relative C—Cl bond strengths.
- (c) In general this question was quite well done with some imaginative answers given for the possible formula for compound **R**. A number of candidates stated that compound **2** would be easily hydrolysed and further responses did suggest to the examiners that some candidates were guessing why compounds **1,2** and **3** did not fit the information given by choosing randomly from the statements provided.

- Q.5** (a) This calculation was mostly attempted in a logical manner with many candidates obtaining propylamine or 1-methylethylamine as their answer and thereby gaining full credit.
- (b) (i) There are now fewer questions that ask for the meaning of a scientific term. More candidates than expected failed to give the meaning of the term 'electrophile'.
- (ii) The accepted answer to this question was 3-methylphenylamine. The examiners were surprised by the number of candidates who could not supply this answer.
- (iii) Many candidates correctly gave 'chromophore' and then obtained the second mark for writing azo-dyes or dyeing (sometimes written as dying!).
- (c) (i) Nearly all candidates wrote that the spots on the chromatogram would be characterised by 2,4-dinitrophenylhydrazine and their presence would be shown as an orange-red colour. Fewer candidates were able to state that this reaction was an addition reaction followed by elimination or a condensation.
- (ii) This chromatography question was generally answered quite well and a number of candidates gave the expected formula of the alkene, although fewer could name it correctly.
- (iii) A number of candidates did not refer their answer back to the equation on the previous page (as outlined in bold) and instead, used the alkene that they had deduced in part (ii).
- (d) (i) It was surprising to read that some A2 candidates are still giving word equations when the question asked for an equation. A number of scripts were seen with water omitted as a product. The examiners also expected a 'structured' formula for ethanoic acid and ethyl ethanoate rather than $C_2H_4O_2$ and $C_4H_8O_2$ respectively.
- (ii) A few candidates did not read the question carefully enough and gave an answer based on ethanol rather than on ethanoic acid.
- (iii) The first bullet point did not give the time needed for heating – this point was missed by many candidates.
- (iv) The use of sulfuric acid as a catalyst was well known.
- (v) Some candidates thought that sodium hydrogencarbonate was used to neutralise the sulfuric acid present. The question clearly said that $NaHCO_3$ was added to the distillate, where sulfuric acid would not be present.

CHEMISTRY
General Certificate of Education
Summer 2015
Advanced
CH5

Principal Examiner: Dr Rhodri Thomas

General comments

It was pleasing to see that this CH5 paper was accessible to many but still included questions that succeeded in challenging the most able. A few questions were only answered correctly by a very small number of candidates (Q1b, Q3e, Q3f, Q5b) while some others were answered correctly by almost all (Q2c(iii), Q3b, Q4g(i), Q5a). Fewer candidates gained marks below 20 than in previous years, leading to an increase in the mean mark. Section A was answered less well than Section B, which has been a common feature of recent CH5 papers.

Many candidates were able to manipulate calculations competently, use sensible numbers of significant figures, select appropriate units and convert between different units. In many cases the calculation questions were answered to a higher standard than the recall questions. Questions requiring comparisons and application of knowledge to unknown situations were frequently those that were answered most poorly.

Weaker candidates often gave answers that were unclear or too vague, and lost many marks as a consequence. Some stronger candidates failed to read the questions carefully and gave answers which contained correct chemistry but did not answer the question set.

Atebion Cyfrwng Cymraeg

Roedd y garfan ddiweddaraf o ieuencid Cymru'n sefyll yr arholiad CH5 eleni a braf yw cael nodi fod safon ieithyddol yr atebion a gyflwynwyd yn gyfoethog ac yn addas ac yn esbonio syniadau astrus mewn modd syml a gafaelgar.

Yn gyntaf (ac yn anffodus) mae tueddiad ymysg rhai o ymgeiswyr cyfrwng Cymraeg i fod ychydig yn ofnus o gwestiynau dieithr a gadael gwagleoedd yn hytrach na mentro atebion. Nid yw'r adroddiad hwn yn awgrymu llenwi'r gwagleoedd gyda geiriau gwag ond, weithiau, gall arholwyr wobrwyo ôl dealltwriaeth cefndir neu dystiolaeth fod yr ymgeisydd yn gyfarwydd a rhannau o'r testun.

Am resymau aneglur 'roedd tystiolaeth eleni fod amryw byd o'r ymgeiswyr cyfrwng Cymraeg heb ddysgu y lliwiau a welir mewn adweithiau, e.e. cwestiynau 1(a)(iv), 4(ch), 4(e)(i), 4(e)(ii) a 5(ch). Gwae cemegwyr sy'n deall strwythurau a newidiadau ar lefel atomig ond sy'n anwybyddu yr hyn a welir mewn fflasg a thiwb prawf.

Y ddau fater arall a ddaeth i'r amlwg oedd amharodrwydd yr ymgeiswyr cyfrwng Cymraeg i ddefnyddio'r cysyniad o 'effaith pâr anadweithiol' wrth ateb cwestiwn 3(a) ac i ddefnyddio'r term 'dadleoliad' wrth gymharu boron nitrid a graffit yng nghwestiwn 3(dd). Heblaw am y mân bwyntiau uchod roedd y papurau cyfrwng Cymraeg yn dilyn yr un patrwm a'r papurau cyfrwng Saesneg.

Section A

- Q.1** (a) (i) This was a straightforward recall question however it was disappointing to see many vague answers that did not refer to key concepts such as the presence of a lone pair.
- (ii) Many candidates failed to represent the three dimensional structure of these ions, whilst others drew the structure containing water ligands carelessly, with the hydrogen atoms bonded to the metal ion. A few candidates wrote the formula of one or more of the water molecules as O_2H which caused them to lose the mark, and this incorrect formula for water has been noted as a problem in previous exam papers.
- (iii) Most candidates gained two or three marks here. For all but the poorest candidates, the marks lost were for unclear or incomplete concepts. Weaker candidates stated that the d -orbital (singular) was split rather than the d -orbitals or d -sub-shell and frequently did not associate this splitting with the presence of ligands. These candidates also incorrectly referred to light being emitted as being the cause of the colour.
- (iv) The colour was generally correct with many giving the correct complex however, incorrect charges or incorrect formulae such as $[Cu(H_2O)_4(NH_3)_2]^{2+}$ or $[Cu(H_2O)_2(NH_2)_4]^{2+}$, were also commonly seen.
- (b) (i) A significant majority gained this mark. Only the weakest candidates lost the mark for misunderstanding, such as using square brackets, having the products as the denominator of the expression or having the sum of the partial pressures, rather than the product, as the numerator. Some candidates were careless and wrote the expression incorrectly with expressions such as $pCl_3 \times pCl_2 / pCl_5$.
- (ii) Few gained this mark, with 1.7×10^5 Pa being the most common incorrect value. The application of stoichiometry to reacting amounts is often challenging to candidates however it was disappointing to see a question with 1:1:1 ratios causing such a problem.
- II The partial pressure of PCl_5 was correct for only a few candidates, however the remaining steps were generally correct.
- III Most candidates identified this as an endothermic reaction or having a positive enthalpy change. The reasons given were usually correct however a few were too vague or incomplete to gain the mark.
- (c) Many candidates gave the correct equation. The reason was generally correct, however some candidates lost the mark for lack of precision or detail.

- Q.2** (a) This calculation provided the widest range of answers of any calculation on the paper, with a relatively even distribution of marks from 0 to 3. In a small selection of 25 exam papers, over 20 different answers were seen!
- (b) Most were able to relate the entropies of the substances to the freedom or disorder in the different physical states.
- (c) (i) The most common errors here were forgetting the conversion of J into kJ or selecting the incorrect enthalpy value, such as the one calculated in part (a).
- (ii) Most candidates were able to connect the feasibility of the reaction to the sign of the Gibbs free energy. Fewer were able to explain why the reaction was feasible at all temperatures.
- (iii) This was well answered.
- Q.3** (a) Most candidates were aware of the inert pair effect in this context however weaker candidates incorrectly discussed the concept of octet expansion.
- (b) Almost all candidates were able to gain the marks for empirical formula. A few found the molecular formula more challenging. A small number lost marks for incorrectly writing formulae such as BrH_3 .
- (c) Most gained this mark but some did not state that the electron deficiency was in the outer shell.
- (d) It was pleasing to see that this challenging equation was balanced correctly by most.
- (e) Few gained this mark as they did not relate the sign to the stability of the elements. Weaker candidates used terms such as 'not very stable' which were vague and gained no credit.
- (f) Few candidates were able to gain full marks here. Many did not focus on the requirements of the question where comparisons in bonding and structure were needed. Some described graphite only, and so gained no credit, whilst others described uses and properties and did not gain marks for this. Some candidates used diagrams effectively to illustrate their structures however others included four-valent atoms where hexagons met.
- (g) This was poorly answered, with 6 being the most common incorrect answer for the mass number. It was disappointing to see candidates using decimal places in their mass or atomic numbers, and some gave symbols in place of mass number, atomic number or both.

Section B

- Q.4**
- (a) Many suggested distillation here and lost the mark. Filtration was mentioned only by a minority of candidates.
 - (b) Many were able to recall the half-equation for the reduction of manganate(VII) ions.
 - (c) (i) This was generally well answered.
(ii) This challenged some candidates, however most were able to combine the half-equation from part (b) with the one given in the question. This was the case even when the half-equation in (b) was incorrect.
 - (d) Most knew that manganate(VII) was linked to a colour change and so was self-indicating. Some lost the mark by listing incorrect colour changes, such as orange to green.
 - (e) This was generally well answered although a few lost a mark for using all volumes, including the anomalous value. Most scored at least 2/4 with the majority gaining 3 or 4.
 - (f) (i) Most were able to write expressions for K_a although some incorrectly stated $[H^+]^2$ as the numerator for the expression.
(ii) Many were very familiar with calculating pH values, and able to find the correct value here. The most common error was to use 0.02 as the concentration rather than 0.2.
(iii) Poor learning of the buffer definition resulted in many vague answers, with many missing out the addition of small amounts of acid or base.

There were two approaches to describing the mechanism of operation of the buffer mixture. The majority of candidates scored their marks by using the HCOOH equilibrium as the basis for their response. A few lost the equilibrium mark as they used CH₃COOH instead. Some candidates gave the equilibrium equations but didn't know how to explain how this helped in mopping up any added acid or base. A few candidates incorrectly gave the sodium methanoate dissociation as an equilibrium. Candidates using the alternative approach frequently referred to the sodium methanoate, rather than the methanoate ions, reacting with any added H⁺ ions.
 - (g) (i) Most were able to recall this colour change.
(ii) Only a minority were able to gain both marks here. Few were able to identify the chromium-containing ion with many suggesting species such as $[Cr(OH)_4]^-$ and suggesting green as a colour.

- Q.5** (a) This was very well recalled with few unable to give the correct colour and identify the precipitate as lead(II) iodide.
- (b) Few candidates were able to gain marks here. The vast majority identified the precipitate as copper(II) iodide, with some identifying it as iodine. Even those few that realised that this was copper(I) iodide rarely wrote the equation for its production clearly. It was common to see equations with one product only, even though the scheme shows two products for the reaction.
- (c) There were two approaches to this question. Some candidates calculated the EMF for both processes and linked the sign of the value to the feasibility. These candidates generally gained high marks. Other candidates linked the standard electrode potentials to the strength of the halogens as oxidising agents. Some gained good marks for this approach, but many gave unclear answers. The confusion between iodine and iodide etc. was evident in many of these answers. Answers such as 'bromide is a stronger oxidising agent than iodide' were penalised.
- (d) Many candidates were able to give the many products and observations for this reaction, although some connected these incorrectly such as 'rotten egg smell of sulfur dioxide. A few candidates were convinced that the reaction produced hydrogen gas.
- (e) (i) Most knew that the colour change was key here, although some failed to mention the time taken. Weaker candidates suggested a gradual change studied by colorimetry.
- (ii) Many candidates calculated both pH values but did not give the difference. In this case either the arithmetical difference of 0.09 mol dm^{-3} or the 10 times factor were accepted. Some candidates lost marks for stating the concentration of H^+ ions was greater at pH 2.
- II This was generally well answered. The most common error was to find the order for iodide as 2, which shows these candidates were only familiar with dealing with cases where concentrations were doubled.
- III Almost all could use their rate equation to find a value for the rate constant. A few found the units more problematic but most still gained this mark.
- IV Few gained the mark for this question as it required discussion of the rate equation and rate constant. Most described the increase in the rate constant but few mentioned the rate equation being unchanged.

CHEMISTRY
General Certificate of Education
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Advanced
CH6

Principal Examiner: Dr Peter Blake

A high standard of performance has continued in this, the penultimate, year of the current A2 coursework unit. The new specification for Wales will have both written and practical units and continue to focus on the same key aims of practical work.

Administration

Although most centres present their candidates work very well, problems for the markers still arise in a few cases so that a restatement is necessary.

1. Cover sheet

This sheet must be signed by the candidate and countersigned by the teacher; otherwise a mark of zero is given. For each candidate, the cover sheet should be placed on top of the two experiment pro formas and all three documents should be bound together using a treasury tag.

2. Teacher result sheets

These are essential for all A2 experiments as a basis for marking the candidate's work and especially for 6I.2 and 6O.2 where great care is needed to ensure that the examiner is totally clear as to which candidate had which set of unknowns. This has not always been the case. If candidates are in different sets or otherwise have different materials this must be totally clear if errors that could be disastrous for the candidates grades are to be avoided. It is realized that a balance has to be struck between avoiding copying between candidates and excessive complexity.

3. Forbidden combinations

6I.2 and 6O.2 cannot both be submitted for the same candidate as this combination does not allow candidates to show evidence of ability in the required skills of preparation, measurement and calculation.

4. New pro formas only to be used

It is essential that no old pro formas are used. Outdated sheets, which did not include the correct questions, were seen this year.

5. No marking by teacher

All marking is done by WJEC.

6. Order of scripts

Candidate work **must** be arranged in the order given on the attendance register.

7. Candidate Instruction Sheets

These should not be included with the work sent to examiners. They add weight and to the difficulty of locating the pro formas.

General points

Significant figures

Marks are still being lost in otherwise good work through incorrect use of these, especially in over-truncation. All results should be expressed according to the precision of the measuring equipment used (e.g., burette readings to 0.05 cm^3); more figures may be used during any calculation but the final result must reflect this precision.

Two-place balances

If only these are available experiments 6.11, 6.13 and 6.14 cannot be chosen since weighing 0.200 g gives an immediate and substantial loss of precision.

Questions in the Evaluation sections are sometimes relatively weakly answered and care and thought must be applied. Remember that all questions are “open book” so that there is no excuse for incorrect responses.

The boxes in which the teacher should mark an assessment of the sample quality in 6.11 and 6.14 are not always completed.

Individual experiments

6.11 - The value derived for x should be close to the theoretical of 2.0. Higher values are usually the result of the sample not being completely dry so that the drying stage given in the procedure is important. In Q6 candidates explanations must be clear and show understanding.

6.12 - Not to be paired with O2. It is essential that the inferences derived from the observations of the tests are made to link to the identities of the unknowns; use of the three-column tables in the pro forma is strongly preferred for this purpose. Omission of the inference stage will lead to loss of marks even if the results are correct. All six salts must be positively identified. There is no longer any need to write out all the equations, just to list the number of precipitates expected in each case.

6.13 - This experiment has become more popular and generally works well. A variety of hydrated salts may be used and also the anhydrous form. Non-integral values of x may legitimately be obtained and candidates should not be worried about small negative values of x which may be a small difference between large numbers. Candidates and teacher must use the identical solution, preferably at the same time to avoid temperature and other uncertainties affecting the saturated solution. Calculation of the equilibrium constant can cause difficulties.

6.14 - It is worth re-emphasising the important note in part B that the KI solution must be added to each of the three solutions immediately before it is titrated to prevent catalysed air-oxidation of the iodide.

6.01 - The preparation works well with the main problem being loss of product during the work-up stages. The detailed procedure section needs to be followed carefully and patiently keeping the volumes used to a minimum, when yields in excess of 70 % are obtainable. The evidence this year is that work-up procedures are improving and many good yields were obtained by both candidates and teachers.

6.02 - Not to be paired with I2. As in I2 it is important to state fully the inferences made as a result of the observations of the results of the tests. These are preferably entered under 'Inferences' in the three-column table and linked to the results table. All six compounds must be positively identified. Again, there is no mark for writing out equations or structures.

6.03 - A long-standing and reliable experiment that can be carried out at a one-third scale using 3.4 g of ester and 3.0 g of the nitro-ester for hydrolysis.

6.04 - A few problems have been reported with Preparation 2, despite this diazotisation and coupling experiment being of some antiquity. Temperature control is important, with slow nitrite addition, while maintaining temperatures in the 5-10°C range (preferably around 7°C). The diazotised amine should be very slowly (dropwise) added to the alkaline phenol with stirring so that the phenol is always in excess to prevent unwanted side reactions and poor yields.

Questions

Information for these open book questions may be independently obtained from any source and may or may not lie within the content of the specification.

Conclusion

This list of problems should not obscure the fact that a very good year's work was achieved for which both candidates and staff are to be congratulated.



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