



GCE EXAMINERS' REPORTS

**CHEMISTRY
AS/Advanced**

SUMMER 2014

Grade boundary information for this subject is available on the WJEC public website at:
<https://www.wjecservices.co.uk/MarkToUMS/default.aspx?!=en>

Online results analysis

WJEC provides information to examination centres via the WJEC secure website. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.

Annual Statistical Report

The annual Statistical Report (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

Unit	Page
CH1	1
CH2	5
CH3	10
CH4	13
CH5	17
CH6	21

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced Subsidiary/Advanced
CH1

Principal Examiner: Kathryn Foster

General

The paper proved accessible with all marking points being gained by some candidates. Able candidates achieved very high marks but even weak candidates were able to match some of the marking points. In nearly all scripts all questions had been attempted and therefore it did not appear that lack of time was a significant factor in candidates' performance.

It was pleasing to note that, in general, candidates coped well with the calculations and many also gave logical, well expressed responses when longer descriptive answers were needed. It was however noticeable that a large number of marks were lost, even by higher scoring candidates, when the response given did not actually answer the question set. It appears that, on occasions, candidates see a particular word and base their answer on what they know about that word rather than actually reading what is required. Examples of this are given below.

Comments on Individual Questions

SECTION A

- Q.1 Most candidates can write electronic structures with only a few incorrect responses seen. These responses generally gave the structure of the sulfur atom rather than the sulfide ion.
- Q.2 The use of carbon-12 was known by nearly all candidates.
- Q.3 The vast majority of candidates correctly identified a suitable reaction and the catalyst needed. Iron in the Haber process was the most popular answer.
- Q.4 Most answers seen were correct with only a few candidates not including the value for $10H_2O$ correctly.
- Q.5 Most answers were correct and included, as required, the negative sign.
- Q.6 Most candidates correctly identified the isotope of thorium but a significant minority did not recognise the increase in atomic number that occurs as a result of β -emission.
- Q.7 Many acceptable diagrams were seen. Some candidates did not clearly indicate the fraction that reacted and gained no credit. Shading was accepted as showing the reacting fraction.

SECTION B

- Q.8 (a) This is an example where many candidates merely saw the word 'isotope' and then defined it. To gain full credit it was necessary, as stated in the question, to consider the specific isotopes mentioned.
- (b) Most candidates drew lines to show the energy levels becoming closer but a significant number drew the arrow head on the energy change facing downwards.
- (c) (i) The fact that the Balmer series lies in the visible part of the spectrum was generally known.
- (ii) Most candidates stated that the Balmer series was not suitable to calculate the ionisation energy and many said that this was because the energy changes involved $n = 2$. Fewer went on to state that the Lyman series or the energy change from $n = 1$ should be used.
- (d) (i) Most candidates knew that ionisation involved the loss of an electron and the formation of a positive ion but a large number omitted the state symbols needed.
- (ii) Although Group 6 was stated by many, a significant minority gave the answer as Group 3.
- (iii) It was pleasing to note that many candidates know that shielding, proton number and distance of the electron being removed from the nucleus need to be considered. Some answers lacked the required precision of expression, for example, stating that T is bigger than S gained no credit.
- Q.9 (a) (i) Although many acceptable lines were drawn, some were shown being deflected more than X, some were deflected in the wrong direction and others, having initially been deflected less than X, were then shown coming through the slit.
- (ii) Most candidates realised that altering the strength of the magnetic field would *alter* the path of the ion but, since the question stated that Y has a higher mass to charge ratio, it was necessary to state that the strength should be *increased*.
- (b) (i) The need to use isotope 37 was generally recognised but a number did not include 2 atoms and others omitted the positive charge.
- (ii) For full credit it was necessary to draw a line at m/z 72 and to make its height 6 (relative to the ones shown being in the ratio 9:1). The first mark was scored by many but the second only by the most able.
- (c) (i) As noted above it was pleasing to see that candidates were clearly aware of how to find an empirical formula. However a number did not recognise that the percentages given did not add up to 100 and that the percentage of hydrogen had to be calculated.
- (ii) Precision of scientific language was important here – relative molecular/ molar mass were acceptable but mass alone was not.
- (iii) This was another example where few candidates read the question with sufficient care. Very many answered the question based on the features of a mass spectrometer rather than the features of the actual mass spectrum.

- Q.10 (a) Most candidates gave an acceptable statement with only a few omitting the fact that it is the *rate* of the forward and reverse reactions that must be the same.
- (b) It was obvious that candidates were familiar with le Chatelier's principle and how to apply it to a specific equilibrium. However a large number did not then include in their answer what was seen when the conditions change. Candidates should be advised to note when words in a question are emboldened.
- (c) (i) It was again pleasing to note that candidates could correctly solve problems based on masses, volumes and moles. A small number used 14 g (rather than 14 kg) or did not recognise that 3 mol of gas would be formed from each mol of hydrazine used.
- (ii) This mark was gained only by a small number of candidates. Many, instead of thinking in terms of the propulsion mentioned in the question, gave answers in terms of using hydrogen as a fuel or the fact that greenhouse gases were not involved in the reaction.
- (d) (i) Most gave an acceptable definition.
- (ii) Completion of this equation proved a challenge for many, with a wide variety of products being suggested.
- (iii) From the explanations given, it appeared that most candidates were able to apply the definitions of an acid and a base to less familiar situations.
- Q.11 (a) (i) Unlike in 10(d)(iii), few candidates were able to apply the definition to a particular situation. Equations were commonly given that were enthalpy changes of combustion or somehow involved $\Delta H_{\text{reagents}}$ and $\Delta H_{\text{products}}$.
- (ii) Although a significant number of candidates did give acceptable answers a large number answered in terms of it not being possible to measure the temperature change involved in the reaction.
- (b) As with previous calculations most candidates showed that they understood the theory involved in the question. Again, in spite of the instruction being in bold, a number did not give the final answer correct to three significant figures. A small number tried to give their answer to this degree of accuracy but failed to do so correctly.
- (c) Most candidates correctly realised that some form of heat loss was inevitable in a laboratory based practical.
- (d) (i) This equation was given correctly more often than that in (a)(i) with most candidates giving carbon dioxide and water as products of the reaction.
- (ii) and (iii) Only the most able candidates showed that they understood the basis of these questions – that bond breaking requires energy but that bond making releases it. The vast majority of answers stated that the enthalpy changes were negative because more energy was needed to break stronger or more bonds.
- (e) A wide variety of answers were acceptable and many candidates used chemical principles to discuss both processes in a logical manner.

- Q.12 (a) Nearly all answers were correctly focused on surface area or rate of reaction.
- (b) Whilst a large number of correct equations were seen it was disappointing to note the number of candidates giving an incorrect formula for magnesium chloride or suggesting H_2CO_3 as a product of the reaction.
- (c) Although some answers showed good understanding a number were seen in which candidates stated that the rate increased with time or suggested that it only slowed after a certain time. For full credit it was necessary to state that, after a certain time, the reaction had actually stopped.
- (d) Since the concentration of the acid used was not stated, answers based on calculating the number of moles of acid and magnesium carbonate were not valid. The question shows data from a practical procedure and as such answers based on practical observations, such as the complete disappearance of the solid, were required.
- (e) (i) Most candidates realised that they needed to use the 200 cm^3 of gas produced and many correctly calculated the number of moles. Some however did not convert from cm^3 to dm^3 in this calculation when using 24 dm^3 .
- (ii) Most candidates who had found the number of moles of magnesium carbonate used the M_r correctly to calculate the percentage present in hydromagnesite.
- (f) Although the diagram showed the gas being collected over water, many candidates did not appreciate that the gas was not appreciably more likely to escape using this method of collection than it was using a gas syringe. They did not link the diagram to the known solubility of carbon dioxide in water.
- (g) Apart from a few candidates who used the relative masses of incorrect species, most were aware of how to calculate the atom economy.

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced Subsidiary/Advanced
CH2

Principal Examiner: Rhodri Thomas

General Comments

This was the first session when almost all candidates attempting CH2 for the first time also attempted CH1. This did not seem to impact upon performance in the areas of overlap such as calculations and mass spectrometry with the marks gained in these being similar to previous summer CH2 exams. The paper showed a very wide range of marks with the highest being 77 and the very best candidates generally lost their few marks through careless work such as not addressing one point in an extended question or using incorrect units in a calculation, rather than a lack of understanding. It was disappointing to see several candidates unable to gain the small number of marks which overlapped with GCSE content.

Previously examiners have commented on the inability of many candidates to write chemical equations so it was pleasing to see the majority were able to produce correctly balanced equations, with some confident in using ionic equations. It was also pleasing to note that a significant number of candidates performed well in the few calculation questions. Many marks were lost by weaker candidates due to a lack of precision in answers, with vague answers that did not identify reagents, conditions or products unambiguously. It was worrying to see that the answers to questions requiring a comparison were often incomplete e.g. they included the observation relating to only one compound when a chemical test to distinguish between two compounds was required. It is clear that some candidates do not understand the difference between intermolecular and intramolecular forces and their effects, and this is reflected in their answers to many questions.

There was significant variation in the questions that challenged different candidates and centres may find it useful to use the item level data available to aid candidates with specific areas for development.

Atebion Cyfrwng Cymraeg

Gwelwyd safon iaith da iawn yn y papurau cyfrwng Cymraeg eleni, gyda'r mwyafrif yn ennill y marciau am ansawdd eu cyfathrebu ysgrifenedig. Roedd iaith rhai ymgeiswyr yn rhy amhendiant, ond roedd cynifer o ymgeiswyr cyfrwng Cymraeg a chyfrwng Saesneg yn dangos y broblem hon, yn enwedig pan yn cymharu ac yn trafod grymoedd/bondiau. Rhaid sicrhau fod atebion yn hollol sbesiffig ac yn osgoi'r defnydd o 'e' a 'hi' lle nad yw'n glir beth y maent yn eu cyfeirio ato.

Defnyddiwyd yr enwau cemegol cywir am y cyfansoddion a'r adweithiau dan sylw gan y mwyafrif. Gwelwyd rhai problemau yn y defnydd o dermeg, ac roedd yr un cymysgwch ag arfer yn y defnydd o'r termau 'atom', 'moleciwl', 'grŵp' ac 'ion'. Roedd hwn yn broblem yn enwedig yn y cwestiynau canlynol:

Cwestiwn 7(c)(i) – Roedd nifer yn trafod atomau neu moleciwlau o sodiwm neu bromid (neu bromin!) yn hydoddi.

Cwestiwn 9(c)(ii) – Roedd sawl ymgeisydd yn labelu'r diagram gydag 'atom o Fe' ac 'atom o O' yn hytrach nag ionau.

Cwestiwn 9(dd) – Unwaith eto gwelwyd trafodaeth o 'atomau' o haearn gydag electronau wedi eu dadleoli rhyngddynt. Mae'r defnydd o'r term 'ion' yn lle 'atom' yn gwneud y datganiad yn gywir.

Cwestiwn 10(a)(ii) a 10(b)(ii) – Trwy gamddefnyddio'r termau 'atom' a 'moleciwl' newidiwyd ystyr atebion rhai ymgeiswyr o fod yn gywir i fod yn anghywir. Roedd ymgeiswyr oedd yn trafod grymoedd van der Waals neu bondiau hydrogen rhwng yr atomau yn colli marciau sylweddol.

Gwelwyd fwy o ymgeiswyr yn y papurau cyfrwng Cymraeg na'r Saesneg yn defnyddio'r term 'dwr bromid' yn lle 'dwr bromin' a cholli marc am hwn. Gwelwyd hefyd y term 'dellten' yn llai aml na'r term Saesneg cyfatebol wrth ateb cwestiwn 9(dd), gyda fwy o ymgeiswyr cyfrwng Cymraeg yn disgrifio neu defnyddio diagram er mwyn ennill y marc yn hytrach na ddefnyddio'r term.

SECTION A

1		Most candidates answered this correctly, but a significant minority thought that hydrogen bonding was the strongest. It is important that candidates are able to differentiate between intermolecular and intramolecular forces and understand that intramolecular forces are always much stronger than intermolecular forces.
2		Few candidates gained this mark as many did not include both numbers needed. It was common to see answers where the prefixes hex- or prop- were used in place of pent-.
3		This was answered well by many. A few candidates drew diagrams containing only one chlorine atom combining with calcium, and it was very disappointing to see some answers indicating covalent bonding.
4	(a)	This was generally well answered but some candidates failed to identify the dipole on the O—Cl bond.
	(b)	Many gained a mark in this question, but there were two common errors that were penalised. Some candidates lost marks for failing to make a comparison – where an answer states the difference in electronegativity between aluminium and oxygen is large then there needs to be a statement regarding the difference between aluminium and chlorine. Another group of answers compared the electronegativity of oxygen and chlorine without looking at the electronegativity difference with aluminium, and this was not sufficient to gain the mark.
5		Most answers correctly identified the reagent required, although a few were penalised for referring to bromide rather than bromine. Amongst the many wrong suggestions were NaOH/soda lime, litmus, emulsion test, dichromate, silver nitrate, ethanoic acid, carbonic acid and barium chloride. It was not generally possible to gain the observation marks without the correct reagent. It was common for candidates to lose the mark for the observations by giving only one observation rather than the observations for both compounds as the question required. Some candidates did not distinguish between 'colourless' and 'clear'.
6		This was generally well answered although some candidates thought that ammonium has bond angles below 109°, presumably due to the misconception that positive charge will cause distortion away from tetrahedral.

SECTION B

7	(a) (i)	Most candidates gained at least one mark here but it was surprising to see such a large number and variety of incorrect answers here preventing candidates from gaining full marks. The incorrect observations given in some cases were surprising as they did not match the observations expected in any inorganic reactions in the A-level course. A variety of precipitate and solution colours including red, orange and purple were seen.
	(ii)	Many candidates showed a lack of understanding of the solubility patterns of compounds, with some suggesting the precipitate was potassium nitrate, others including hydroxide ions in the precipitate and still others generating seemingly random compounds. The equation was generally correct for those who identified the correct precipitate but for others there were many clear misconceptions, with any compound ions included represented by a wide range of incorrect formulae.
	(b)	The question stem states that each test allowed some compounds to be distinguished. It was disappointing when candidates stated that all compounds gave the same (or no) result in any test, and it was not uncommon to see this as an answer to any of the parts of the question.
	(i)	This was poorly answered. A minority seemed to realise that sodium hydroxide was basic and a significant number thought that magnesium nitrate or barium chloride were acidic.
	(ii)	Most knew the majority of flame test colours and it was good to see that fewer candidates thought that magnesium nitrate gave a bright white flame than in some previous papers. A common error was to describe the colour of the flame test for barium as red.
	(iii)	There were many blank answers here. Most candidates who attempted the question identified the correct observation, and could link this to barium chloride although too many thought that more than one of the solutions would give a precipitate. A precipitate of potassium sulfate was often referred to.
	(c) (i)	Many candidates gained marks in this question, but there were also a wide range of errors leading to the loss of one or both marks. There were many references to hydrogen bonding, dipoles on NaBr and even covalent bonds or sodium bromide molecules. Some thought a reaction was occurring and gave equations, mentioned precipitates or wrote about a brown solution.
	(ii)	This was well answered, although a few candidates chose white and cream respectively as the colours of the precipitates.
	(iii)	Most candidates identified the reagent as ammonia solution, however the observations needed to match the concentration of ammonia used and in some cases the ammonia was described as dilute or concentrated but the observations matched the other. This was not given full credit.
	(iv)	It is disappointing to see candidates give equations that are not balanced. Some candidates were also unable to give the correct formula for a sodium halide, with NaBr ₂ being seen as well as bromine being written as 2Br.
8	(a)	Many gained good marks here however several candidates discussed the breaking of covalent bonds and so gained no marks. Some candidates who identified the forces as van der Waals did not indicate that these were intermolecular and others did not relate these to boiling temperature.
	(b) (i)	This was attempted by almost all candidates, and well answered by some. Two common errors were ignoring the factor of 1000 required to convert the kg given into g and assuming that all the mass given was butane, rather than only 1.2 % of the mass.
	(ii) I	Very well answered.

	II	Very well answered.
	III	Generally well answered although some candidates referred to propane radicals rather than propyl radicals.
	(c)	This question was well answered by many, with most candidates gaining at least 3 marks and many gaining all 6. There were six bullet points listed in the question and it was surprising to see many candidates not addressing these or using them as a guide to the structure of their answer. The most common errors seen were incomplete equations, such as an absence of 'n' in the polymerisation of ethene and the use of the repeat unit in place of the monomer for an alternative polymer. Some candidates did not include the idea of 'many' monomers when defining polymerisation.
9	(a)	Most candidates could balance this equation.
	(b)	Most candidates were able to attempt this although answers of +6 for the oxidation state of iron were seen in some cases. Most were able to use oxidation states to identify oxidation and reduction but some ignored the requirement to use oxidation states and referred only to electron gain and loss.
	(c) (i)	Most candidates could give the correct answer although a few gave the number 6 alone. Only a very small number gave 8:8.
	(ii)	This question was poorly answered. Many candidates drew parts of crystal structures that did not completely show the arrangement of oxide ions around any one of the iron ions. Many others showed six oxide ions around an iron ion without indicating the three dimensional nature of the arrangement which led to representations which were effectively hexagonal planar. Some labelled their diagrams as Fe atoms and O atoms.
	(d)	Almost all candidates were able to gain these marks.
	(e)	This question was poorly answered. Some candidates did not mention the sharing of an electron pair. More mentioned that a coordinate bond had both electrons originating from one atom, but failed to mention that the covalent bond had one electron originating from each atom that formed the bond.
	(f)	Most candidates gained some marks here, but few gained all marks. This was frequently due to unclear language such as interchanging the words atom / ion / nucleus which made areas of their answers incorrect e.g. 'strong electrostatic forces between the iron atoms and delocalised electrons'. Weaker answers included discussion of covalent bonds or apparent confusion between metallic bonding and the bonding in graphite. It was not uncommon to see discussions of cations and anions. Answers were often very good or very poor with few in between.
10	(a) (i)	Many candidates gained both marks but some lost marks for not identifying the fact that the sodium hydroxide should be used in aqueous solution, to distinguish it from the alcoholic sodium hydroxide used to make an alkene from the same starting material. Ethanolic sodium hydroxide was stated by many as the reagent.
	(ii)	Many candidates gained some marks here, with most of these gaining at least 2 marks. The most common reason for losing one mark was not giving the details for the insolubility of 1-bromobutane. Candidates who gained no marks here often referred to the breaking of covalent bonds or the reaction of water with bromobutane or butanol. The idea of 'like dissolves like' was used by some candidates but this alone was not considered to demonstrate the required level of understanding.
	(b) (i)	Many candidates gained two marks here, although some lost one mark as they did not indicate that dichromate(VI) / manganate(VII) must be acidified. A common error was to refer to phosphoric acid catalyst at 300°C.

	(ii)	Fewer candidates gained full marks for this question. Many candidates lost marks by discussing the breaking of the C=O double bond which shows a fundamental misunderstanding of the factors that govern boiling temperature. Others lost a mark for not indicating clearly that the forces being discussed were intermolecular.
	(iii)	This was answered well by better candidates but a range of errors were seen, with seemingly every separation method or reaction in the course suggested by at least one candidate.
11	(a) (i)	Better candidates gained all the marks here, although some lost marks through careless drawing of the arrows so that they did not clearly begin at a bond, lone pair or negative charge. Other candidates lost marks for showing the electrons coming from H—Br towards the alkene, or had the bromide attaching to the alkene in the first stage followed by protonation in the second. Another error seen many times was the use of partial charges on the bromide or carbocation in the second stage.
	(ii)	Many candidates gained both marks here, but some answers simply stated Markovnikov's rule and did not explain the reasons for this. The answer "2-bromopropane is more stable than 1-bromopropane" was also common and gained no marks.
	(b)	Almost all candidates were able to identify the empirical formula. Most were able to interpret the absorptions in the infrared spectrum, although some lost a mark for assigning 3030 cm^{-1} as O—H or not assigning all three. Fewer were able to correctly interpret the mass spectrum data and use it to deduce the molecular formula, with some assigning the peaks at 120 and 122 as $\text{C}_3\text{H}_5\text{Br}$ and $\text{C}_3\text{H}_7\text{Br}$. Many were able to provide the correct structure without all this data, although some drew the E-isomer despite the question stating that it was the Z-isomer.

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced Subsidiary/Advanced
CH3

Principal Examiner: Peter Blake

General Comments

This has been another successful year for the AS practical unit.

Looking at the work of the candidates one realises that they have been exposed to training in the basic chemical procedures of weighing, measuring, solution preparation, calculating, error analysis and evaluating. Although the equipment used (burettes, flasks, coffee cups, glass thermometers, etc.) may seem primitive in the context of modern laboratory apparatus, these basics apply to all work.

Since the range of exercises available does not change, the comments in the report tend to be rather similar from year to year but it is worthwhile making one general comment. Usually the raw data obtained from the experiments are of a very good standard but marks are often lost in the data-processing steps, notably involving graph plotting and the use of significant figures. This will be discussed below.

Administration

Usually this is efficiently dealt with by the teacher but every year there are a few cases of serious omission or ambiguity, probably involving teachers who are new to the system and who would benefit from a restatement.

1. **Cover sheets.** These must accompany all work and it is **essential** that each is signed by the candidate and authenticated by the teacher. **Otherwise a mark of zero will be recorded.**
2. **Teacher result sheets.** These are essential for the marking of experiments 3.1A-D and 3.3A-C and must be clear and free from ambiguity. In addition, if different candidates are in different sets or otherwise have different solutions this must be made completely clear to the examiners if errors are to be avoided.
3. **New proformas only.** The use of old proformas can cause marking errors. It is essential that only up-to-date versions are used. These should be downloaded from the WJEC secure website in the second half of the autumn term.
4. **Order of work.** All candidates' work must be arranged in the order given on the attendance register.

5. **Solids in thermochemistry.** Every year there are a few cases in which the teacher's value for $\Delta T/g$ is far less than that expected for the pure, dry solid, e.g. 5 for MgO as against 15. Through no fault of their own the candidates - whose marks are based on the teacher's results - may suffer through being provided with impure or, worse, heterogeneous material. Thus a candidate's grade may be endangered by a failure to provide a supply of a pure, dry and relatively cheap material.
6. **No instruction sheets or rough work.** Ensure that only pro formas, graphs and a minimum of additional sheets are included. Strongly encourage the full use of pro formas. A plethora of unnecessary additional sheets seriously interferes with the marking process and can lead to errors.
7. **No plastic covers, no paper clips.** Use one treasury tag in the top left corner to attach the candidate cover sheet and both pieces of work.
8. **No marking by teacher.** A few, perhaps new, teachers need to be told that all marking is done by WJEC.

Processing of Experimental Results

1. Graphs

These are required in all experiments 3.1 and 3.2 and the same general points must be adhered to.

The graph must be titled, the appropriate axes used, the axes labelled and suitable scales chosen. All points must be clearly marked, the whole of the graph paper should be used and lines of best fit drawn that may not pass through some of the points.

In thermochemistry graphs, do not start the T axis at 0°C. In kinetics exercises, graphs for 3.2A need six points and those for 3.2B each require four points, one of which is common to both graphs.

2. Significant figures

The number of figures quoted in the **final** result must reflect the precision of the experiment. This is commonly around 1%, giving three sig. figs, e.g. 1.02 ± 0.01 . It is unscientific to record the complete output of the calculator since the later numbers are meaningless. A more serious error is to discard information by over-truncation, such as returning a result of 0.0944 as 0.09 or, worse, as 0.1.

In titrations marks are commonly lost by not quoting burette readings to 0.05 cm³, especially by writing initial readings as 0.0 or, worse, as 0, and in kinetics by writing volumes used as, e.g., 10 and not 10.0 cm³ and truncating 1/time values, such as writing 1/42 as 0.02 instead of 0.023.

In weighings, masses must be given to the full precision of the balance, such as 0.900 g and not 0.9 g. Also great care must be taken to ensure that masses are correct since mistakes here will affect all the subsequent results. In particular, such errors in thermochemistry are uncorrectable.

3. Errors

An estimate of the error in an experiment is essential if we are to understand the meaning and reliability of the result. At AS only a simple approach is needed in which the main source of error is identified, e.g., burette, balance or thermometer, and expressed as a percentage of the measurement being made. This might give 0.10 cm³ in 20 cm³, 0.001g in 0.100g and 0.2°C in 10°C respectively in these cases and thus errors of 0.5%, 1% and 2%. All these being around 1% would lead to three significant figures being used. There would be no harm in using four significant figures; remember that all of these are "guesstimates".

AO1 and AO2 Questions

These are open book with a focus on information gathering from any source rather than recall and may not all be covered in the specification.

Specific points

Thermochemistry

Do **not** choose 3.1B or 3.1C (0.100 g of Mg) if only two-place balances are available. Pure, dry solids are essential and should be trialled in advance (see 5. above) Rapid stirring is important in obtaining accurate ΔT results.

Kinetics

There are five marks given for at least a threefold range in concentration and two marks for a sensible range in reaction times.

The trial run result should be included in the points plotted.

Titrations

A proper titration table, sufficient values that are concordant within 0.25 cm^3 and correct averaging of indicated results to within 0.05 cm^3 are each awarded one mark.

Planning

Two marks are allocated for the plan which should be a brief statement of what is to be done, using chemical terms such as titration, endpoint and extrapolation as appropriate without needing to explain their meaning. Important steps such as the need for stirring in the solids in thermochemistry should be given but there is no need to repeat in detail the masses and volumes already given in the Apparatus and Chemicals section nor to describe the apparatus used.

Conclusion

The experiments work well within their limitations and both candidates and teachers should feel satisfied over a job well done.

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced
CH4

Principal Examiner: David Ballard

General Comments

This paper was more accessible to candidates than the corresponding paper in June 2013 and, as a result a number of papers were seen where candidates scored freely. There were fewer papers with lower marks and, in general, the wide range of marks seen in previous papers was not so evident.

The papers showed clear evidence of good preparation for the examination. The comprehension section about ethers was designed to have nearly all the material that was provided to be relevant to the questions that followed.

As in previous examinations in this unit there were relatively few questions that needed numerical answers and these were generally answered in a competent way. Some candidates did not use the given mole ratio but then processed the subsequent stages correctly, gaining marks under the 'error carried forward' principle.

Some errors were noted where candidates were careless in drawing structures, for example bonds going from a carbon atom to the hydrogen in an —OH group or bonds to hydrogen atoms shown as sticks with no atom attached. In questions that required explanations of new situations the answers were sometimes rather brief and too general in nature.

In general 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 no evidence of candidates having to rush questions in section B.

SECTION A

- Q.1 (a) (i) This question asked candidates to give the equation for the reaction, rather than the mechanism. A number of scripts were seen where HCl was not given as one of the products. Some candidates gave a chlorine radical as one of the reactants rather than the required molecular chlorine.
- (ii) The carbon-containing radical that leads to 2-chloropropane was often incorrect. The examiners felt that the 'dot' needed to be associated with the second carbon atom and not the hydrogen atom bonded to it (or another carbon atom). A few candidates wrongly gave a carbocation.
- (b) Aluminium chloride was usually given. There were some other acceptable answers of which iron(III) chloride was the most commonly seen.

- (c) (i) The answer provided was usually correct but a few candidates lost credit by not indicating that the product was a solid.
- (ii) Most candidates identified the impurity as a ketone but very few realised that the impurity contained two methylketone groups bonded to the ring. A Friedel-Crafts acylation can lead to more than one substitution by a CH_3CO — group. Many candidates gave a structure showing an extended side chain.
- (d) (i) Although many candidates gave potassium manganate(VII) as the correct answer, a few missed out the oxidation state or gave a wrong one.
- (ii) Some candidates did not imply that the acid used was dilute or in aqueous solution.
- (iii) A few candidates gave sodium tetrahydridoborate(III) as their answer but this is not a powerful enough reducing agent to convert a carboxylic acid to a primary alcohol.
- (iv) Nearly all candidates gained this mark. A few, however, drew the structure carelessly with the bond from the ring not leading to the carbon atom of the CH_2Br group and consequently lost credit.
- (e) The differences between the infrared spectra of benzoic acid and phenylmethanol were well known. It was necessary to give the bond and its stretching frequency to gain both marks.
- Q.2 (a) Nearly all candidates could identify the chiral centre.
- (b) (i) 'Acidified potassium dichromate' was the most popular of the correct answers. Some candidates did not state that the reagent needed to be acidified or gave an oxidation state that was wrong.
- (ii) I It was necessary to state or imply that a racemic mixture contained equal 'amounts' of each enantiomer / optical isomer. A commonly seen weakness was to give just 'isomers'.
- II The effect of a racemic mixture on the plane of polarised light was usually given correctly.
- (c) (i) Although nearly all candidates stated that but-2-enoic acid had *E-Z* isomers, some candidates did not state clearly which carbon atoms had different groups attached.
- (ii) There were a number of acceptable answers but vague answers such as 'conditions' needed more detail to gain any credit.
- (d) Some candidates gave the wrong reagents (including triiodomethane) as the reagent(s) but the observation was generally correct.
- (e) This question was too often poorly answered. The NMR spectrum of the compound had two discrete signals, both singlets. Many candidates were unable to describe and explain the key features of the spectrum in a clear and logical manner. The interpretation of the signals using the provided data sheet was often incorrect. A few candidates discussed its infrared spectrum.

- Q.3 These questions were focused on the article 'The chemistry of some compounds containing the ether (R—O—R) linkage'.
- (a)
 - (i) Although this question was often well answered with clear steps being shown, a number of candidates did not recognise that there was a 2:1 mole ratio to be considered in working out the answer.
 - (ii) Most candidates gave ethene as the answer.
 - (iii) Some candidates spoilt their answer by giving too many irrelevant partial charges in the mechanism. Care should be taken in the writing of 'curly arrows' both in their origin and their destination.
 - (iv) The explanation for hydrogen bonding was sometimes unclear. For example, candidates simply stating that the other molecule had to contain an oxygen atom.
 - (b)
 - (i) It was very common to see candidates missing out the CH₃O— and —OH groups or only giving a monobrominated species.
 - (c) The test using iron(III) chloride was usually correct.
 - (d)
 - (i) The question asked for the molecular formula of anethole. It was surprising to be given a structural formula, when only C₁₀H₁₂O was required.
 - (ii) This question proved challenging as candidates needed to realise that the product had to be a phenol with a saturated side chain as HBr would also add across the double bond.
 - (e) The displayed formula was generally correct but some candidates did not provide a compound with the correct number of carbon atoms. Although many candidates stated that the compound was a carboxylic acid, some spoilt their answer by instead giving 'carboxyl' or even 'carbonyl'.

SECTION B

- Q.4 (a)
 - (i) Distillation was the commonest correct answer.
 - (ii) A correct difference between the two mass spectra gained credit for nearly all candidates.
 - (iii)
 - I Marks were lost by a number of candidates who did not give HCl as the other product in the equation. Other candidates lost the mark by attempting to give the shortened structure for the amide and becoming confused.
 - II This question was generally answered very well with many gaining full credit. A significant number of candidates made no reference to heating and many others lost a mark by referring to 'solvent' rather than the stated 'ethanol'. Candidates were required to clearly specify how the compound (melting at 60 °C) would be dried.

- (iv) I There was some confusion between 'nitrate' and nitrite'. It may be safer to give the formula of the nitrite as part of the answer.
 - II Although the formula of the azo dye was usually correctly given, common errors included a lack of a methyl group on the ring and attachment of the azo group to the wrong carbon atom of the naphthalene ring.
 - (b) (i) A number of candidates did not obtain full credit for the mechanism. Common errors included a lack of charge for the cyanide ion, incorrect polarisation and unclear curly arrows.
 - (ii) It was usual to award two marks with the third mark being lost for the colour (or rather lack of colour) resulting from the absorption of blue light. Common incorrect responses for this third mark included yellow, red, colourless and clear.
 - (iii) The formula for the hydrolysis product of mandelonitrile was, surprisingly, often given wrongly. An amine or a product lacking an —OH group was sometimes seen.
- Q.5 (a) Candidates were asked to use each piece of information provided. This led, in some cases, to a loss of credit. The second bullet point indicated that the empirical formula was also the molecular formula – this statement was often omitted. Although some candidates identified the presence of an ethyl group from the mass spectrum, they then gave a final structure that did not include this group. In general, however, the examiners were pleased with the logical approach adopted by many candidates that led to the deduction of a correct structure.
- (b) (i) The equation for the cracking of undecane was usually correct but some candidates seemed unsure of the formulae of hexane and propene.
 - (ii) The calculation for the percentage by volume of propene from the gas chromatogram was often correct but some candidates rounded 15.3% up to 16% and lost credit.
 - (iii) There were a number of acceptable answers to this question and many candidates gained all three marks but, in questions of this type, candidates should beware of repetition of the same points.
 - (iv) A number of candidates failed to realise that both alcohol groups of the diol would be esterified by its reaction with ethanoic acid.
- (c) (i) Some candidates spoilt their response by giving a repeating structure derived from ethane-1,2-diol rather than propane-1,3-diol. Sometimes oxygen atoms were omitted from the otherwise correct repeating structure.
 - (ii) Candidates answered this question very well and showed a good understanding of polymerisation. It was pleasing to see each bullet point clearly addressed in most candidates' answers.

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced
CH5

Principal Examiner: Elfed Charles

General Comments

Over 2000 candidates sat the paper and the mean mark was 45.5. There was a good spread of marks, with the highest being 78 and the lowest 0. Many good scripts and only a few very poor scripts were seen. Section A was answered slightly better than Section B.

The calculations proved to be a mixed bag with many well done e.g. Q.2(c) (pH of a buffer solution), Q.3(d)(iii) (redox titration), Q.4(c)(i) (free energy), with others e.g. Q.2(b)(ii) (pH of HCl in water), Q.5(e)(iii) (equilibrium constant), which required some degree of manipulation, causing major problems.

The quality of written communication was good on the whole when required to write extended answers e.g. Q.3(c)(ii) (colour in transition complexes), Q.4(b)(i) (graphite and boron nitride), but there were a number of examples where candidates showed a lack of clarity or did not read the question properly and so failed to gain full credit e.g. Q.2(d) (buffer solutions), Q.5(d)(ii) (electrochemistry).

The ability to write equations and simple chemical formulae again proved to be too demanding for many candidates. It is apparent that some have made little progress in understanding from GCSE level.

Papur Arholiad Cymraeg

Ar un adeg, ystyriwyd papurau Cemeg cyfrwng Cymraeg fel pethau dieithr, a chredwyd bod dewis cyfrwng Cymraeg yn weithred 'ddewr' ar ran yr ymgeiswyr. Wrth drugaredd, mae'r dyddiau hynny wedi hen fynd heibio, a pheth cwbl naturiol yw astudio a sefyll arholiad trwy gyfrwng y Gymraeg. Mae'r papur CH5 yn dystiolaeth o'r hyder newydd hwn a gwelwyd enghreifftiau o ysgrifennu graenus a phwrpasol o bob un o'r canolfannau. Er y darlun cadarnhaol hwn, trueni oedd gweld ambell i unigolyn yn dechrau ateb yn y Gymraeg ond yn llithro i'r Saesneg cyn diwedd y papur arholiad. Efallai dyma ganlyniad byw mewn gwlad ddwyieithog.

Yn fwy penodol, roedd rhai gwahaniaethau rhwng y sgrïptiau cyfrwng Cymraeg a'r sgrïptiau cyfrwng Saesneg yn dod i'r amlwg. Cafwyd enghraifft yng nghwestiwn 2(ch). Roedd nifer o'r ymgeiswyr cyfrwng Cymraeg yn mynnu cynnig atebion wedi'u selio ar asid cryf ac asid gwan ac o ganlyniad yn anwybyddu'r syniad o 'byffer'. Yna, yng nghwestiwn 3(c)(i), roedd nifer yn cyfeirio at 'rhifau ocsidiad' gwahanol yn hytrach na 'cyflyrau ocsidiad'. Ar y llaw arall, atebodd yr ymgeiswyr cyfrwng Cymraeg gwestiwn 3(ch)(iii) a chwestiwn 5(ch)(i) yn ddeheuig gan ddangos cryn ddealltwriaeth. Anodd fyddai cynnig eglurhad dros y man-wahaniaethau hyn rhwng atebion ymgeiswyr yn y ddwy iaith.

I gloi, roedd hwn yn bapur a atebwyd yn hynod o dderbynniol gan yr ymgeiswyr cyfrwng Cymraeg, a phob clod iddynt am eu hymdrechion.

SECTION A

- Q.1 (a) A fair start to the paper with over half the candidates giving both correct pairs. However, a significant number identified two species instead of two pairs and so lost at least one mark.
- (b) (i) Well answered with over half of candidates obtaining full marks and the vast majority gaining at least one mark. The concentration in experiment 3 proved to be the most difficult to calculate.
- (ii) The rate constant calculation was well done but some candidates got confused with the units.
- (iii) Most knew that the value of the rate constant remained unchanged.
- (iv) Most candidates were able to link an increase in the rate constant to an increase in reaction rate, however only a few managed to obtain both marks by referring to concentration remaining constant.
- Q.2 (a) Generally well answered. The vast majority knew the expression for K_w , however a significant number gave an incorrect unit.
- (b) (i) The vast majority scored at least one mark, with most getting both marks. The main error was not linking the H^+ concentration to pH.
- (ii) This proved to be a tricky calculation. Only about a third managed to gain both marks and almost half the candidates failed to score a mark. The 990 cm^3 of water confused many, while a significant number completely ignored it and just used an acid concentration of 0.10 giving a pH of 1.
- (c) This pH calculation was well done and over half obtained all 3 marks. The most common mistake was to state that $[H^+] = [CH_3COO^-]$.
- (d) Only a minority scored the full 3 marks on this part. Over a third did not realise that the solution in part (c) was a buffer solution and so failed to gain any mark. For those who realised that it was a buffer solution, imprecise terminology, such as 'sodium ethanoate removes H^+ ', was frequently used. Correctly written equations were scarce, with the dissociation of sodium ethanoate often given as an equilibrium.
- Q.3 (a) The bonding in hydrogen peroxide proved challenging for many candidates and only about half gave a correct diagram.
- (b) Generally poorly answered. Although the majority of candidates could calculate the number of moles of oxygen, less than half could calculate the concentration of hydrogen peroxide.
- (c) (i) Poor use of language lost marks in this question. 'Various' or 'many' were often seen instead of 'variable' for oxidation states and 'empty' or 'unfilled' instead of 'partially filled' for d-orbitals.
- (ii) It was pleasing to see many excellent answers. Over three-quarters gained at least four marks out of five. Most candidates knew about d-orbital splitting, however a few still mixed up colour by absorption and by emission.

- (d) (i) Well answered. This half equation is specifically stated in the specification, *topic 15.1*, and about two-thirds could recall it.
- (ii) Using this half-equation and a given half-equation to deduce an overall equation proved far more difficult. Many candidates did not carry all the species in the half-equations through to their overall equation while others did not balance the equation properly.
- (iii) This redox calculation was very well answered and almost three-quarters scored all three marks. The main error was made in the stoichiometric ratio.
- (e) This proved to be the hardest question on the entire paper. Only a few candidates realised that the oxidation state of oxygen in hydrogen peroxide is -1. Most thought that oxygen changed from -2 to 0 and that hydrogen changed from +2 to +1.

SECTION B

- Q.4 (a) This part was about the chemistry of lead. It was generally well answered with the mean score being around four out of six.

In part (i) over two-thirds knew that lead(IV) oxide was an oxidising agent.

Part (ii) was disappointing. Only about a third of candidates gained both marks while a third failed to gain any marks. A common mistake was to simply state lead chloride for solid **A**. Hydrogen chloride and hydrogen were common incorrect responses for gas **B**.

Only just over half could give a correct formula for solution **D** in part (iii).

Part (iv) was the best answered part of the entire paper. Almost all candidates knew that lead(II) iodide was yellow.

In part (v) only just over half could write a correct equation for this simple reaction despite being given the names of the reactants and products. At the end of a two year A level course this is extremely disappointing.

- (b) (i) This part required the candidates to write fluently about the structure of graphite and to compare it with boron nitride. Although only a minority gained full marks, over two-thirds scored at least three marks out of five. Again, lack of clarity was responsible for losing marks.

Many candidates assumed that the bonding between carbon atoms was covalent without stating this and 'isoelectric' was commonly used instead of 'isoelectronic'.

A significant number explained why graphite conducts electricity without explaining why boron nitride does not.
- (ii) Most candidates could give a use of cubic boron nitride.

- (c) (i) Very well answered. Around three-quarters scored all three marks for this free energy calculation. A significant number did not calculate ΔS properly and so lost one mark.
- (ii) Difficult question. About one-third gained a mark. A few realised that constant changes in temperature meant constant changes between tin's two forms. Others got credit for stating that as the temperature got colder the tin would exist as the unstable grey form.
- (d) (i) A significant number knew the overall equation for a hydrogen fuel cell, however the electrode half-equations were not well known.
- (ii) The vast majority could give a disadvantage of using hydrogen fuel cells.
- Q.5 (a) This part was about the reaction of chlorine with sodium hydroxide. Most knew the equation for the reaction with cold aqueous sodium hydroxide and could classify the reaction as disproportionation but only just over a third could write the equation for the reaction with hot aqueous sodium hydroxide.
- (b) The reason why period 3 elements can show octet expansion but period 2 elements cannot was poorly explained. Too many simply stated that phosphorus has d-orbitals while nitrogen does not without mentioning accessibility or octet expansion.
- (c) This part required the candidates to explain why many ionic compounds are soluble. Again only a minority gained all five marks but over two-thirds scored at least three marks.
- Most could name the enthalpy processes involved but a significant number got endothermic / exothermic the wrong way round. The main error was a failure to clearly show how solubility depended on these enthalpy changes, although most realised that the enthalpy change of solution had to be negative for the compound to be soluble. A few did not specify if the lattice enthalpy was for formation or for breaking and so lost a mark.
- (d) (i) Once again imprecise descriptions caused a loss of marks. A significant number gave 'iodine' as the reducing agent instead of 'iodide' and so lost a mark.
- (ii) The vast majority correctly calculated the e.m.f. for the process, but less than one in five could write a correct cell diagram.
- (e) (i) Writing an expression for K_c was very well done. Over two-thirds scored both marks. Some lost a mark for omitting water from the expression but surprisingly more lost a mark for not giving a unit instead of writing 'no unit'.
- (ii) Extremely well answered, almost all correctly calculated the moles of ethanoic acid.
- (iii) This proved to be the hardest calculation in the paper. Most candidates had little idea how to find the equilibrium concentrations and so could not calculate K_c . About two-thirds failed to score a mark.
- (iv) A good finish for most, with over three-quarters correctly explaining what happened to the value of K_c as temperature is increased.

CHEMISTRY
General Certificate of Education
Summer 2014
Advanced
CH6

Principal Examiner: Peter Blake

General Comments

A very successful year for the A2 practical unit with many very high marks being obtained. On looking through the scripts one realises that the experiments provide a good test of skills required at A level and that these have been impressively coped with in most cases.

Administration

Very few problems here but it is clear that some points need to be made, probably for teachers new to the system.

- 1. Cover sheets.** These must accompany all work and it is **essential** that each is signed by the candidate and authenticated by the teacher. **Otherwise a mark of zero will be recorded.**
- 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. [See Sample Allocation sheets]. This is not always the case. If candidates are in different sets or otherwise have different materials this must be totally clear if errors are to be avoided.
- 3. Forbidden combinations.** 6I.2 and 6O.2 cannot both be submitted. This has occurred again despite repeated statements on this point. The centre disadvantages its candidates since they can show no evidence of ability in the required skills of preparation, measurement and calculation.
- 4. New proformas only.** The use of old proformas can cause marking errors. It is essential that only up-to-date versions are used. These should be downloaded from the WJEC secure website in the second half of the autumn term.
- 5. No marking by teacher.** All marking is done by WJEC.
- 6. Order of work.** All candidates' work must be arranged in the order given on the attendance register.

General points

Significant figures

Marks are still being lost in otherwise good work through incorrect use of significant figures, 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 cm³). 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 AO1 and AO2 questions are “open book”.

The boxes in which the teacher enters a mark as 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 value. Higher values are usually the result of the sample not being completely dry so that the drying stage given in the Procedure is important.
- 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 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 teachers 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 in 3. 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.O1 The preparation works well, 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.
- 6.O2 **Not to be paired with I2.** As in I2 it is again 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.

- 6.O3 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.O4 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 (pref. 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.

AO1 and AO2 questions

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



WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk