WJEC
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GENERAL CERTIFICATE OF EDUCATION
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EXAMINERS' REPORTS

CHEMISTRY (LEGACY)
AS/Advanced

JANUARY 2009

Statistical Information

This booklet contains summary details for each unit: number entered; maximum mark available; mean mark achieved; grade ranges. *N.B. These refer to 'raw marks' used in the initial assessment, rather than to the uniform marks reported when results are issued.*

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.

CHEMISTRY

General Certificate of Education

January 2009

Advanced Subsidiary/Advanced

Principal Examiner: *Elfed W. Charles*

Unit Statistics

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

Unit	Entry	Max Mark	Mean Mark
CH1	356	66	38.0

Grade Ranges

A	49
B	44
C	39
D	34
E	29

N.B. The marks given above are raw marks and not uniform marks.

Chemistry CH1

General Comments

356 candidates sat this paper and almost all of them were retaking the unit. It was felt that the paper gave plenty of opportunity for all candidates to show positive achievement. There were many excellent scripts which showed the value of sound revision and about 15% of the candidates gained 80% or more, while only around 3% of the candidates scored 20% or less.

The highest mark was 61 and the lowest 5. As expected, Section A was answered well. In Section B the most successfully answered question as a whole was Q.9 with Q.11 being the least successfully answered. The easiest parts on the entire paper proved to be Q.3 (ii), Q.12 (d) (ii) and Q.10 (b), while the hardest parts were Q.6, Q.11 (b) (i) and Q.9 (b) (iii) in that order.

It was pleasing to note that most of the candidates performed very well in the calculation questions. Also the use of chemical equations e.g. Q10 (c), Q12 (c) (ii) was better than in the past, but forming an ionic equation Q11 (b) (iii) still proved too much for most candidates. Also answers that required detailed responses often lacked content in depth and were sometimes contradictory for a significant number of candidates. This was particularly true in Question 9 (c) diamond and graphite and Question 12 (b) intermolecular bonding.

Atebion Cyfrwng Cymraeg

Gyda sampl fechan mae’n hawdd cael yr argraff anghywir. Serch hynny, gwelwyd sgriptiau da iawn ac roedd safon yr iaith a ddefnyddiwyd gan yr ymgeiswyr yn foddhaol iawn. Roedd ymgeiswyr yn defnyddio’r termau Cymraeg yn hyderus mewn gwaith estynedig a gwelwyd iaith raenus mewn llawer o’r atebion hirach, fel disgrifiad diemwnt a graffit. 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

The candidates generally scored quite well in this section, with the average mark being just over 6 out of 10.

Q.1 A good start with around three quarters of candidates giving the correct electronic configuration of an atom of magnesium.

Q.2 Most knew that both iodine and solid sodium chloride do not conduct electricity.

Q.3 Part (i) was only fairly well answered with about a half giving the correct answer. Some incorrectly labelled the anion as bromine while others thought that Li^+ was the anion.
Part (ii) was the best answered part of the whole paper. Almost all candidates knew that the crystal co-ordination number was 6:6.

Q.4 Again well answered; about three quarters correctly identified D as the Group II element.

Q.5 The vast majority could calculate the relative atomic mass of the sample of nickel and give it to three significant figures, as required.

Q.6 The worst answered part in the whole paper. Only about 1 in 5 candidates could correctly state which statement was true for an ideal gas. The most popular incorrect answer was A 'ideal gases are considered to have no volume'.

Q.7 Well answered; most correctly stated that the oxidation number of chromium in CrO_2Cl_2 is +6.

Q.8 Only about a third of candidates gave a correct balanced equation. The most common errors were to give CaO instead of $Ca(OH)_2$ or to omit the H_2.

Section B

Q.9 This was the most successfully answered question in this section.

(a) About three quarters of candidates knew the relative mass and charge of the particles in atomic nuclei. A minority thought that nuclei contained α and β particles.

(b) (i) Most candidates could successfully explain 'half-life', however some lost the mark due to use of imprecise language such as 'the time taken for an atom to lose half its mass'.

(ii) Well answered about two thirds gave the correct mass number and symbol.

(iii) Poorly answered. Less than a third of candidates could explain what happens in an atom's nucleus when a β-particle forms.

(iv) The vast majority knew that magnesium is essential in photosynthesis.

(c) This question about the bonding in diamond and graphite produced a wide range of answers but was generally well answered. About half the candidates managed to score at least 5 marks out of 7 with the average mark being around 4½.

The main errors were:
(i) omitting 'covalent' in the description
(ii) diagrams contradicting the written accounts e.g. in the number of bonds on each carbon
(iii) failing to mention which property was common / different
(iv) explaining the reasons for the high melting temperatures of the substances.

(d) Very well answered. The vast majority correctly deduced that the empirical formula was RbC_{20}.

Q.10 (a) (i) Fairly well answered. Despite the question clearly asking candidates to explain redox in terms of electron transfer, a significant number explained in terms of oxidation numbers and so lost a mark.

(ii) Under two thirds got the full two marks for this standard question on ionic bonding. There were many ambiguous answers. There should be two clear steps – one showing the atoms donating/receiving electrons and the other showing the charges on the ions formed. Some candidates even showed covalent bonding.

(iii) Most candidates gained the flame test mark for calcium. A common incorrect answer was to give precipitation of carbonate as a test.

(b) This calculation was extremely well done with the vast majority scoring full marks.

(c) Most candidates knew that a white precipitate is seen when aqueous solutions of magnesium ions and hydroxide ions are mixed, however only stronger candidates could give the ionic equation for the reaction.

(d) The first part of the question compared the first two ionisation energies of magnesium and calcium while the second compared the first two ionisation energies of magnesium and sodium. Both parts were answered fairly well with most candidates gaining at least one mark in each part. However only about a third obtained full marks.
The main errors were:
(i) a failure to use the comparative e.g 'the second electron is shielded from the nucleus' instead of '…is shielded **more**…'
(ii) stating that 'calcium has more electrons than magnesium' instead of 'calcium has an extra shell of electrons'
(iii) stating that the most important factor governing ionisation energies is the stability of full shells.

Q.11 This was the least successfully answered question in this section.

(a) (i) Most candidates knew why methane has a tetrahedral shape, unfortunately a lack of precision flawed most answers. Far too many candidates described the shape in terms of repulsion between 'hydrogens' or 'atoms' instead of 'electron pairs'.

(ii) There was a better response to the difference in shape between methane and water molecules, although some lost marks by not specifying the number of lone pairs of electrons in a water molecule.

(b) (i) Very poorly answered. About half the candidates could identify CuO as the basic oxide but only about 1 in 5 could state why it is a basic oxide.

(ii) This calculation was generally well done. Most candidates gained at least one mark with a high proportion gaining the full three marks.

(iii) It was pleasing to see so many candidates writing a balanced chemical equation.

(c) This question asked the candidates to explain why sodium chloride and ethanol are soluble in water. The second part was better answered. In the first part many candidates showed the sodium and chloride ions as $Na^{\delta+}$ and $Cl^{\delta-}$ respectively, while others showed hydrogen bonding between the NaCl and water.

In the second part many gained both marks from good labelled diagrams. Some lost marks by being too vague e.g. 'ethanol is polar, therefore ethanol can dissolve in water', while others thought that ethanol contained OH^- ions.

(d) Most candidates stated that the molecules would gain more energy as the temperature increases, but the majority failed to link this increase with the ability to overcome the bonding between the water molecules.

Q.12 (a) (i) Disappointingly answered. Only about 2 in 5 candidates correctly explained the meaning of electronegativity. Most failed to realise that electronegativity cannot be assessed until the atom is covalently bonded to another.

(ii) Generally well answered. The main error was to show the C – I bonds as polar.

(b) In this question the trend in the boiling temperatures of the hydrogen halides had to be explained. Only the more capable candidates managed to clearly explain the differences in terms of van der Waals and hydrogen bonding. Although many stated that hydrogen bonding was present in hydrogen fluoride, they did not say where or stated vaguely that it was 'between hydrogen and fluorine'. Poorer answers gave responses in terms of 'bonds breaking' with no reference to van der Waals forces between molecules of HCl, HBr and HI.

(c) (i) The test for aqueous iodide ions was well known. A common error was to add aqueous NaOH before adding aqueous $AgNO_3$, however if aqueous HNO_3 was added after the NaOH no marks were lost.

(ii) Surprisingly only about a third of candidates gave the correct observation for the reaction between chlorine and potassium iodide solution. The most common errors were stating 'orange-brown' or 'blue-black' solutions.

Most candidates managed to write a balanced equation.

(d) Very well answered. The vast majority could define 'isotope' and successfully do the half-life calculation.

CHEMISTRY

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Unit Statistics

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Unit	Entry	Max Mark	Mean Mark
CH2	656	66	38.3

Grade Ranges

A	47
B	42
C	37
D	32
E	27

N.B. The marks given above are raw marks and not uniform marks.

Chemistry CH2

General Comments

656 candidates sat this paper and almost all of them were retaking the unit. It was felt that the paper gave plenty of opportunity for all candidates to show positive achievement. There were many excellent scripts which showed the value of sound revision and about 12% of the candidates gained 80% or more, while only around 3% of the candidates scored 20% or less.

The highest mark was 62 and the lowest 2. As expected, Section A was answered well. In Section B the most successfully answered question as a whole was Q.6 with Q.7 being the least successfully answered. The easiest parts on the entire paper proved to be Q.2 (a), Q.8 (c) and Q.9 (a), while the hardest parts were Q.7 (a) (i), Q.8 (b) and Q.7 (b) (iii) in that order.

The standard of presentation of answers for many candidates was quite high and these papers were a pleasure to mark. The examiners felt that the calculations in this paper were handled with confidence. However, for a significant minority of candidates, answers that required detailed responses often lacked content in depth. This was particularly true when writing about the bonding in ethene (Question 8(a) (iii)) and the Contact process (Question 9 (d)).

The Organic Chemistry questions were answered better than the Physical Chemistry questions, suggesting that candidates have benefited from extra work on the CH4 module since their first attempts at CH2.

Atebion Cyfrwng Cymraeg

Gyda sampl fechan mae'n hawdd cael yr argraff anghywir. Serch hynny, gwelwyd sgriptiau da iawn ac roedd safon yr iaith a ddefnyddiwyd gan yr ymgeiswyr yn foddhaol iawn. Roedd ymgeiswyr yn defnyddio'r termau Cymraeg yn hyderus mewn gwaith estynedig a gwelwyd iaith raenus mewn llawer o'r atebion hirach, fel disgrifiad adeiledd a bondio ethen a'r broses Cyffwrdd. Foddbynnag, roedd diffyg cywirdeb i'w weld gan rai ymgeiswyr mewn atebion byrach fel dosbarthu adweithiau gyda nifer ohonynt yn mynd yn ôl at y termau Saesneg.

Section A

The candidates generally scored well in this section, with the average mark being almost 7 out of 10.

Q.1 Good start with about three quarters of candidates giving the correct structural formula for 2-chloropropene.

Q.2 (a) The best answered part in the whole paper. Almost all candidates gave a correct equation.

(b) Again well answered. The majority could correctly give a suitable reason as to why cracking is important.

Q.3 (a) Fairly well answered. The vast majority knew that the position of equilibrium would shift to the right, but only about 1 in 5 knew that the value of K_p would increase.

(b) The conditions for the Haber process were very well known, with about two thirds gaining both marks. Some candidates lost a mark by giving the temperature instead of the pressure.

Q.4 About half the candidates correctly stated why ammonia is a nucleophilic reagent. The most common mistakes were a failure to refer to ammonia or to state that ammonia had a negative charge.

Q.5 Well answered. Most candidates knew that CFCs are responsible for the decomposition of ozone, however a significant number lost the second mark due to the answers being too vague.

Section B

Q.6 This was the most successfully answered question in this section.

(a) In parts (i) and (ii) the idea of energy profiles was well understood. The commonest error was to see the concept confused with distribution curves. Surprisingly, in part (iii), less than two thirds could give the correct expression for K_p and state that there were no units.

In part (iv), only about half the candidates could state that the equilibrium yield of hydrogen iodide does not change because there are equal number of moles of gaseous products on each side of the equation.

(b) This question asked to explain the effect of temperature change on the rate of a reaction and although three quarters of candidates gained at least two marks out of three, only about a quarter obtained all three marks. The main weaknesses were not referring to the activation energy and not stating successful collisions per unit time.

(c) This acid-base calculation where candidates had to calculate the percentage of sodium carbonate in washing soda was well answered. A significant number scored all five marks and due to consequential marking most candidates obtained at least three marks. The main errors were not dividing by a thousand when calculating the moles of acid and failing to work out the correct M_r of sodium carbonate even though the formula was given.

Q.7 This was the least successfully question answered in this section.

(a) (i) The worst answered part in the whole paper. Although about 1 in 3 candidates could correctly define ΔH^{θ}_{f}, very few gave the standard temperature and pressure conditions. Many incorrectly stated 'the enthalpy required' rather than 'the enthalpy change' and some omitted '1 mole' from the definition.

(ii) About half the candidates gave a correct reason as to why NO_2 was more stable than NO.

(iii) Most candidates gained the correct answer by using ΣH_f products - ΣH_f reactants. Some credit was given for giving an enthalpy change with the correct magnitude but the wrong sign.

(iv) Well answered. Over two thirds managed to write a balanced equation.

(b) (i) Most candidates managed to write the correct expression for the acid dissociation constant of ethanoic acid and give the units.

(ii) The explanation of strong and dilute as applied to acid solutions was generally well answered. However candidates lost marks by being imprecise, referring to 'readily' instead of 'fully' or giving vague statements such as 'low pH' and 'high K_a' in the case of strong acids and referring to 'H^+' concentration in the case of dilute acids.

(iii) Poorly answered. Candidates did not associate the addition of sodium hydroxide as reacting with H^+ ions and so they could not apply Le Chatelier's principle correctly.

(c) Well answered. The question asked for reagents and observations when identifying a carboxylic acid. Many candidates obtained both marks, but a significant number lost a mark by giving a statement such as 'carbon dioxide is evolved' which is a conclusion not an observation.

Q.8 (a) (i) This question was about the reactions of ethene and it was generally well answered. The structures of the products of the reactions were well known. However fewer candidates were able to recall appropriate conditions or to classify the reaction. For the conditions either the name of the catalyst or the heat required was omitted and too many considered the reaction of bromine to be ‘addition’ instead of ‘electrophilic addition’.

(ii) The vast majority knew that the conversion of bromoethane to ethene is elimination but only about half the candidates knew that the reagent is potassium or sodium hydroxide. Even fewer realised that the reagent had to be dissolved in alcohol not water.

(iii) Whereas the structure of ethene was correctly represented diagrammatically by most candidates, only a minority of candidates described the planar nature of the molecule. The types of bonding present in ethene and how they had formed, were also only described by a minority despite the question asking specifically for this.

(b) This question was about boiling temperatures in alkenes and was very poorly answered. Many candidates thought that the number of chemical bonds present or the mass of the molecule were the factors governing the boiling temperature and consequently gave vague answers such as ‘less bonds to break in ethene therefore it has a lower boiling point’ which gained no credit. Many of those who identified van der Waals forces failed to make it clear that they were between the molecules and so lost marks.

(c) Very well done. Some candidates lost a mark by drawing the structure of but-1-ene which was named in the stem of the question and others by sloppily linking the methyl group via the hydrogen to the alkene chain, but over three quarters correctly gave the structures of two isomers of C_4H_8.

Q.9 (a) A high proportion of candidates were able to identify fractional distillation as the process. 'Cracking' was the most common incorrect answer.

(b) The mechanism for the chlorination of methane was generally well answered. Both the initiation and termination stages were very well known, but the propagation stages to produce chloromethane were not described as well.

(c) The vast majority of candidates obtained at least two marks for this bond enthalpy calculation with over half scoring all three marks. The main error was to do the subtraction/addition the wrong way round

(d) The question asked for an account of the Contact process and it was only fairly well done with about half the candidates failing to obtain at least half marks for this part. Fewer than 1 in 5 managed to score at least 6 marks out of 7.

The initial burning of sulphur to form sulphur dioxide was well known. The conversion of sulphur dioxide to sulphur trioxide was more problematical. Many candidates could not produce a balanced equation and they did not know that this is a reversible process.

The operating conditions were generally well known although some candidates did not realise that these are specific to the reversible process. The answer 'vanadium oxide' was not sufficient to identify the catalyst.

Many could not clearly offer an explanation for the choice of the operating conditions. Vague answers such as 'these were the optimum conditions for the best yield' gained no credit. At A-level a specific reference to the effects of changing temperature and pressure on both rate and yield is expected.

The method for obtaining the final product was generally known but the details for the process escaped many. Few realised that the sulphuric acid used must be concentrated, otherwise the problem of the highly exothermic absorption into water would not be avoided. Those that attempted to write equations for this process could correctly give the chemical equation for the formation of oleum, but were unable to balance the equation for the further dilution of this. The incorrect equation below commonly appeared:

$$H_2S_2O_7 + H_2O \longrightarrow H_2SO_4$$

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Principal Examiner: *M. E. Anthoney Ph.D.*

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Unit	Entry	Max Mark	Mean Mark
CH4	1356	75	41.0

Grade Ranges

A	53
B	47
C	41
D	35
E	29

N.B. The marks given above are raw marks and not uniform marks.

CHEMISTRY CH4

General Comments

There were 1356 candidates sitting this paper, an increase of more than 10% on January 2008. The mean mark was 41.0 (maximum 75), very close to that of last winter, and the standard deviation was 14.5.

The worst answered questions were parts (a) and (b) of Q3 covering chromophores and azo dye formation. Q1(c) and Q2(d) proved good discriminators and it was particularly pleasing to see many high scores on Q4 which required candidates to apply their knowledge and interpret data in a series of logical steps.

There was no evidence of candidates having insufficient time to attempt all the questions. Nearly all candidates attempted most questions and there were no dead marks.

Detailed Comments

Section A

Q1 Parts 1(a) and 1(b) were well answered, with a good number of candidates achieving full marks. In contrast, only the best candidates scored well on 1(c), with disappointing answers from many weaker candidates.

(a) A few candidates redrew the examples already given in a different format but otherwise the correct structures were almost always given.

(b) Well answered by even the weaker candidates.

(c) (i) Complete answers were few and far between, though a majority of candidates gained at least one of the two marks. Weak candidates often failed to appreciate that isotopes of chlorine were responsible for there being three molecular ions and a disturbingly large number of candidates confused the terms *isotope* and *isomer*.

(ii) C-Cl was usually correctly identified as the bond being broken, though a common error was to try and explain this in terms of bond polarity rather than bond strength.

(iii) Depletion of the ozone layer was quoted by most candidates, though often as part of a cocktail of environmental problems. To gain both marks, candidates needed to say how the depletion of the ozone layer allows harmful UV radiation to reach the Earth's surface with the resultant increase in cancer etc.

Q2 (a) There were many good answers to this question though a few candidates, after correctly identifying the bond changes, failed to specify, either by wavenumbers or on the diagram, the peaks involved.

(b) Also well answered, though a few candidates failed to give observations for ketones as well as aldehydes.

(c) The iodoform test seems to be better known these days, but a large number of candidates mentioned only the CH_3CO group and failed to give a group for **A**.

(d) This question proved a good discriminator, with only the best candidates giving correct structures. Despite being told that both **A** and **B** are branched compounds, a surprisingly large number drew straight-chain structures, some even managing to omit the groups they had already correctly identified in 2 (c).

(e) Those candidates who had taken the trouble to learn this mechanism scored well, those who had not bothered gained little credit for guesswork.

Q3 (a) (i) Very few candidates failed to give the correct wavelength.

(ii) Blue light is being absorbed, and any answer in the red/ orange / yellow region which showed an appreciation of complementary colours was allowed.

(iii) The azo group, -N=N-, only produces coloured compounds when it is conjugated, so to gain the mark at least a portion of the adjacent benzene rings must be shown as well.

(b) Some good answers, but a disappointing number of scripts were left blank, or almost blank, for this question.

(c) Well answered.

Section B

Candidates responded well to both questions in Section B and many excellent answers were received.

Q4 (a) (i) The test for carboxylic acid was well known. However, a number of candidates persist in giving the "production of gas" as an observation.

(ii) Having correctly calculated the number of moles used, a surprising number of candidates then failed to use this to answer the actual question as to the number of moles of sodium hydroxide which react with one mole of malonic acid.

(iii) A high proportion of candidates deduced the correct structure, but often marks were lost by failing, as instructed, to use all the information given.

(iv) Some leeway was given provided candidates demonstrated an understanding of the nomenclature system , with propanedioic acid, propandioic acid and propanedicarboxylic acid (all either with or without the redundant 1,3 labels) being allowed. Ambiguous or impossible variants such as dipropanoic acid or 1,2 propanedioic acid were disqualified.

(b) The reagents and conditions for Stage 1 and Stage 2 were quite well known. The most frequent errors were to omit any indication of the temperature required (even if it is "room temperature") and to use cyanide under acid conditions.

(c) A pleasingly large number of candidates appreciated that either one or two CO_2 groups could be lost in decarboxylation, giving ethanoic acid and methane as the products.

(d) "CO" is not sufficient to identify the group for which 2,4-DNPH is a test: a more specific answer such as carbonyl group or aldehydes plus ketones is required. Condensation (addition-elimination) was not well known as the type of reaction involved and separation (and purification) of the orange solid was often omitted.

Q5 (a) (i) (I) An encouraging number of candidates carried out the calculation correctly to obtain full marks, though a core of the weakest candidates had little idea of how to begin. Consequential marking meant that those who made an error in working out molar masses could still gain up to 2 marks.

(II) Sadly there were a lot of waffling answers, frequently invoking energy changes, with only the best candidates showing a clear appreciation that every stage involves handling and/ or equilibrium losses, so the more stages there are the greater the overall losses.

(ii) Well answered.

(iii) A number of candidates, ignoring the presence of excess $LiAlH_4$, stopped the acid reduction at the aldehyde stage, and a surprising number managed to lose a carbon from the side chain during the reduction. As in Q4b, mention of room temperature was often omitted from the conditions.

(iv) Dipeptide formation was known by a majority of candidates, though a number gave a peptide link as simply a C-N bond without specifying the other atoms attached to C and N.

(b) The conversion of salicylic acid into aspirin was well known, though the structure of aspirin was less well done.

(c) (i) The 2,4,6-trinitrophenol structure was well answered, though a significant number of candidates showed, presumably through careless drawing, at least one NO_2 group with oxygen rather than nitrogen bonded to the ring.

(ii) The test for phenols was well known.

(iii) Stronger candidates knew the reaction of phenols with alkali, though guesswork from the weak candidates generated an interesting spread of compounds, often with Na covalently bonded to the benzene ring!

(iv) An encouraging number of candidates correctly understood ethanoylation of a phenol to form an ester.

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