

**WELSH JOINT EDUCATION COMMITTEE
CYD-BWYLLGOR ADDYSG CYMRU**

General Certificate of Education

Tystysgrif Addysg Gyffredinol

EXAMINERS' REPORTS

SUMMER 2006

**AS/Advanced
CHEMISTRY**

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**WJEC
CBAC**

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

2006

Advanced Subsidiary/Advanced

Statistical Information

The following information is included in this report in order to provide centres with as full a picture as possible of the examination in each component. The statistics include all candidates entered for the unit, whether or not they 'cashed in' for an AS/A level award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of the paper and that differences will undoubtedly occur between one year and the next and also between subjects in the same year. Moreover, information is provisional in the sense that it does not take account of changes resulting from appeals.

Component	Entry	Max. Mark	Mean Mark	Grade	Raw Mark	Cumulative %
CH1	2137	66	35.6	A	46	27.0
				B	40	41.4
				C	35	54.0
				D	30	66.0
				E	25	77.4
CH2	2564	66	36.0	A	47	26.8
				B	41	39.6
				C	36	52.3
				D	31	64.1
				E	26	75.2
CH3a	2507	30	19.4	A	22	29.5
				E	16	84.2
CH3b	90	103	89.7	A	89	60.0
				E	67	100.0
CH3c	2405	103	86.2	A	89	53.1
				E	67	94.4

Advanced Level

Component	Entry	Max. Mark	Mean Mark	Grade	Raw Mark	Cumulative %
CH4	1042	75	35.8	A	49	19.5
				B	43	34.0
				C	37	49.8
				D	31	64.1
				E	25	76.9
CH5	1443	75	37.0	A	50	22.0
				B	44	37.0
				C	38	51.3
				D	33	61.9
				E	28	72.2
CH6a	1439	50	25.4	A	35	15.1
				E	21	69.8
CH6b	60	103	83.0	A	89	28.3
				E	61	98.3
CH6c	1383	103	86.2	A	89	50.8
				E	61	97.2

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

CHEMISTRY

General Certificate of Education June 2006

Advanced Subsidiary

Paper CH1

Chief Examiner: D.H. Ballard, B.Sc., Ph.D., C.Chem., F.R.S.C.
Lecturer in Science Education, The Nottingham Trent University

General Comments

The range of marks obtained in this Paper was very wide, with a continuing number of candidates who cannot, sadly, obtain a score in double figures. Commendably, however, some very high scores were also seen. The examiners feel that some candidates are unprepared for the increased intellectual rigour of AS level compared with KS4 examinations. In some cases it was obvious that little effort had been made to learn the material during the year or to revise for the examination. As a result, a number of simple questions were answered superficially with answers that reflected basic ignorance of chemical principles.

The use of chemical equations continues to cause problems; some candidates were woefully ignorant of the formulae of compounds such as aluminium oxide and barium sulphate.

Many fine attempts at calculations were seen, although a number of papers were seen where the candidate had not thought whether the answer obtained was reasonable rather than absurd.

There was adequate time allowance for this paper and there were no dead marks.

Section A

- Q.1 The term 'empirical formula' seems to confuse many candidates. A large number gave the molecular formula $C_4H_4O_4$.
- Q.2 Most candidates answered this correctly although a few still believe that hydrogen chloride is ionic, despite the question stating that it was a molecule.
- Q.3 (i) Nearly all candidates correctly gave the electronic structure for an atom of phosphorus.
- (ii) It was unusual to see a correct equation showing the reaction of phosphorus with excess oxygen. The formula of phosphorus(V) oxide is P_4O_{10} ; many gave P_2O_5 . The oxide exists as a bridged tetrahedral structure with a phosphorus atom at each corner. Both P and P_4 were accepted for the element. The question stated that excess oxygen was used but some candidates still persisted in giving P_4O_6 .

- Q.4 The reaction of chlorine with water was well known.
- Q.5 Most candidates knew that diatomic chlorine has a peak at 70 in its mass spectrum.
- Q.6 Nearly all candidates could recognise that the compound giving a green flame and that was also insoluble in water was barium carbonate.
- Q.7 The concept of half life was used by most candidates successfully.
- Q.8 The answer for this question was N_2O_3 but some candidates could not manipulate the relative atomic masses to obtain this formula and left it as numbers.
- Q.9 Nearly all candidates knew that sulphur(VI) fluoride had a bond angle that is less than 90° .

Section B

- Q.10 (a) It was a pity that many candidates did not read the question carefully enough. The element that **decayed** to produce $^{133}\text{Xenon}$ was iodine; many candidates wrote caesium.
- (b) Many candidates noted that four significant figures were required and gave this correctly.
- Some weaker candidates simply added the figures and divided by three.
- (c) (i) Nearly all candidates got this correct.
- (ii) State symbols were often neglected and this was penalised. It was not uncommon to see xenon with a negative charge.
- (iii) The examiners were looking for an increase in size and more shielding for xenon when comparing it with krypton. Sometimes shielding was not mentioned.
- (d) (i) Candidates had a free choice here for a compound that had a polar covalent bond. Obscure compounds (often of noble gases) gained credit but the commonest responses were water and hydrogen chloride. Some gave ionic compounds, although these were not acceptable.
- (ii) If candidates stated that a difference in electronegativity was present between the atoms making the bond, then they gained credit. Sometimes partial charges were the only response; this was not felt to be enough.

- (iii) It was surprising to see numbers of candidates who did not know how to work out oxidation states, even though the oxidation state of fluorine was given. In II, candidates were asked to choose which compound was the oxidising agent, giving a reason for their answer. Many candidates did not understand what was being asked and gave F or Xe, rather than XeF_2 .
- (e) Although the majority of candidates managed to score something, answers were often full of irrelevant information such as stating standard conditions or the gas laws. A significant number described the electronic stability of the noble gases. Imprecise answers such as 'they have no volume' or 'the molecules are always moving' were common.
- Q.11 (a) (i) Many responses were spoiled by a lack of knowledge of the formula of aluminium oxide.
- (ii) Some candidates seemed to be describing the reaction of sodium with water – skidding across the surface and perhaps igniting. The question asked for 'what is seen'; this was not always done and responses such as 'calcium hydroxide is produced' gained no credit. Some candidates described the evolution of gases other than hydrogen; this too was penalised.
- (iii) Surprisingly, some candidates thought that Group 2 elements became less reactive with water as the group was descended.
- (b) This calculation proved to be discriminating. Apart from mathematical errors there was inappropriate use of units in M_r and also not giving units when asked for the mass of water lost.
- (c) (i) Although most candidates knew that silver iodide was a yellow substance, the construction of an ionic equation showing its formation was disappointing. A few invented compounds, such as BaAg . The use of ionic equations seems to be a poorly understood section of the specification.
- (ii) The dark brown solution owes its colour to iodine but few seemed to know this and much guessing occurred. Many did not know the role of bromine in this reaction.
- (iii) It was very disappointing to see how few knew the correct formula of barium sulphate or its colour.
- Q.12 (a) (i) Many candidates seemed uncertain of what was being asked. All that was required was a brief description of the attraction between nuclei and electrons and the repulsion between particles of the same charge but it was not often that a clear answer was seen. Sometimes ionic bonding was described.

- (ii) Many candidates spoiled their answer by calculating the relative molecular mass of mercury(II) oxide as 432 instead of 217 – simply because two moles of the oxide were used in the equation. This showed a lack of basic knowledge of the mole and stoichiometry. A number of candidates then did not divide by two to satisfy the chemical equation.
 - (iii) The vapour pressure curve was generally well completed but some did not use the boiling temperature of mercury which was given in the question.
- (b) Although a number of candidates knew the bond angle was 109° , the diagrams of the shape were often poor. Some looked square planar and some used dot and cross diagrams. The examiners were looking for some attempt at a 3D representation of the tetrahedral structure of the HgI_4^{2-} ion.
 - (c) It was pleasing to see many good responses about hydrogen bonding. Even weaker candidates often managed half marks or more. Most described the very electronegative nature of the elements other than hydrogen that were involved. Sadly, the examiners saw too many diagrams showing water as HO_2 . Many were able to illustrate their answer using ice and many wrote of the high boiling temperature of water, although a relative or comparative was really needed for full credit, as 100°C is not a high temperature.
- Q.13
- (a)
 - (i) Many candidates could describe the bonding in graphite but the responses sometimes lacked clarity. The examiners were looking for **strong** covalent bonding and **weak** Van der Waals forces but these terms were not always given.
 - (ii) Surprisingly, a number of candidates believed that graphite was hard but then described how the layers could be rubbed off onto paper !
 - (b) Marks were often lost here as candidates struggled to find the right terms to describe van der Waals forces. This has always been a difficult area for candidates and continues to be so.
 - (c) The question led candidates through the calculation but a number multiplied by six instead of dividing – again showing weakness in their understanding of stoichiometry. Some had trouble converting cm^3 into dm^3 and obtained rather concentrated solutions !
 - (d)
 - (i) As in previous examinations, a number of candidates thought that the most important factor governing ionisation energy is the stability of full shells. Some believed that the atoms became bigger across a period.
 - (ii) A better response was seen in this section, particularly if the candidates drew the electronic structure of magnesium and aluminium clearly and used these as the basis for their comments.

CYMRAEG

Braf oedd gweld y cynnydd yn y nifer o ganolfannau ac ymgeiswyr ar gyfer y papur cyfrwng Cymraeg. Gwelwyd iaith raenus yn y mwyafrif, ond roedd mynegiant nifer fach o ymgeiswyr yn aneglur ac yn achosi iddynt golli marciau. Roedd mwy o ymgeiswyr yn defnyddio'r termau 'atom' 'moleciwl' ac 'ïon' yn gywir eleni, ond mae rhai yn dal i golli marciau yn ddiangen trwy eu camddefnyddio. Gwelwyd defnydd da o dermau gwyddonol cywir, ond mae amrywiaeth o dermau yn dal i gael eu defnyddio am rai cysyniadau e.e. 'sgrinio', 'cysgodi' a 'tariannu' ar gyfer 'shielding', ac mae angen mwy o gysondeb ar y rhain.

It was pleasing to see an increase in the number of centres and candidates for the Welsh medium paper. A good standard of Welsh was apparent on most scripts, though a few candidates lacked clarity and hence lost marks. More candidates used the terms 'atom', 'molecule' and 'ion' correctly this year, but some still fail to appreciate the differences. Most answers used correct scientific terminology, but some variation was seen with a few terms, most notably 'shielding' which was variously translated as 'sgrinio', 'cysgodi' and 'tariannu', and greater consistency is required here.

CHEMISTRY

General Certificate of Education June 2006

Advanced Subsidiary

Paper CH2

Principal Examiner: M. E. Anthony Ph.D.

General Comments

There were 2552 candidates sitting this paper, of which 202 did so through the medium of Welsh, figures very close to last summer's entry. The mean mark was 36.1 (maximum 66), an increase of 2.2 on last year, with standard deviation 13.9.

There was no evidence of candidates having insufficient time to complete the paper. While some questions were challenging and discriminating, nearly all candidates were able to attempt most questions and there were no dead marks.

Though there were some excellent scripts (highest mark 65), the impression remained of a section of candidates who were totally unprepared for an examination. Many candidates could improve their marks significantly with an effort to tailor their answers to the specific question asked. In many cases, lengthy sections of prose, though not chemically incorrect, gained no credit because they were too vague or too general and did not relate to the question asked.

Detailed Comments

Section A

Most candidates did well in this section, with **Q2**, **Q3**, **Q5** and **Q6** attracting few wrong answers.

- Q.1 The commonest errors were to omit the number in 2-bromopropane and to retain the double bond with "bromopropene".
- Q.4 Surprisingly, this was, by some distance, the most poorly answered question in Section A. Many thought the question asked which of cis **or** trans isomerism the compound would exhibit, others thought two pairs of identical groups are necessary for cis-trans isomerism and a third group commented that the carbon had two hydrogens attached without identifying to which of the two CH₂ groups they were referring.

- Q.7 (i) Many candidates concentrated on the products of homolytic fission rather than the splitting of the covalent bond. There was a widespread misconception that homolytic fission always produces two identical free radicals, presumably since Cl_2 is the most frequently used example.
- (ii) A frustrating and common error was to omit any reference to rates of reaction, e.g., “the reactants and products are equal”.
- Q.8 Although a few weak candidates contrived to produce unlikely answers, the only serious problem was the old chestnut of incorrect sign.

Section B

- Q.9 (a) Many good students obtained maximum marks with a combination of an energy distribution diagram and short explanatory text. Students who chose not to include a diagram generally struggled to explain some of the points such as activation energy. Weaker students often lost marks through scruffily drawn diagrams with inadequate or absent labelling.
- (b) (i) Some students failed to use the symbols given in the question, resulting in confusion.
- (ii) Nearly all candidates scored one mark for 59 kJ mol^{-1} in the correct place, but 175 and 185 kJ mol^{-1} were often mixed up.
- (c) *Heterogeneous* was well explained, but many long, detailed accounts of how *catalysts* work gained no credit because the candidates omitted to state their effect on reaction rate! A significant number of candidates believed all catalysts are biological enzymes.
- (d) Many candidates confused hydrogenation with hydration and included assorted oxygens in the equation.
- (e) Most candidates scored marks on the basic arrangement of single and double bonds in ethene, but maximum marks were rare because of the failure to refer to the molecular structure or to π -bonding. A significant number of candidates did not know the formula for ethene.
- Q.10 (a) (i) The expression for K_a was well known, with the commonest errors being the failure to use appropriate [] brackets and the addition of concentrations rather than their multiplication.
- (a) (ii) The distinction between *weak* and *dilute* was poorly explained, with most answers consisting of vague generalisations.
- (b) The production of CO_2 from carbonate / hydrogencarbonate was well known, though many candidates still fail to give true observations: “Carbon dioxide was produced” is **not** an observation. A few students insisted on adding limewater directly to the reaction mixture to test for CO_2 . Esterification was allowed as an alternative test.

- (c) The oxidation of primary alcohols was well known, though some candidates failed to mention the acidification of dichromate(VI) (or manganate(VII)) or the need for warming.
- (d) Correctly calculated by most candidates. A significant number, having correctly arrived at a C:H:O ratio of 5.16:10.27:1.72 then rounded up to $C_5H_{10}O_2$.
- (e) The answers to this question continued the improvements shown in recent years in candidates' ability to handle titration calculations. A few still find difficulty working with powers of ten, as for example when converting cm^3 to dm^3 .
- (f) No credit was given where candidates failed to compare propanoic acid with water as requested by the question, e.g. "propanoic acid is an acid so will have a low pH".

- Q.11 (a)
- (i) Almost all candidates correctly predicted ΔH_f^\ominus for heptane.
 - (ii) The increase in chain length by one carbon each time was well understood, but only the best candidates appreciated the formation of one C-C and two C-H extra bonds each time.
 - (iii) Most students correctly calculated 94 kJ mol^{-1} though there were the inevitable problems with sign. A pleasing number of candidates realised the value would be the same in the second case and made a reasonable attempt at explaining their reasons. Others took the long route of extrapolating ΔH_f^\ominus for octane and doing a second enthalpy change calculation.
 - (iv) Most answers were correct, though a surprising number of candidates confused cracking and fractional distillation.
- (b)
- (i) Very few candidates simplified the problem by cancelling out bonds present in both reactants and products before substituting values, but a reasonable number still obtained the correct answer.
 - (ii) Whilst addition polymerisation was well known, only the best candidates coped with part II. Most stumbled over a failure to appreciate bond breaking is endothermic and bond making is exothermic.
 - (iii) The correct temperature was better known than the pressure.
 - (iv) "Unbonded electrons" or "free electrons" were frequently incorrectly used as alternatives to the unpaired electron(s) in free radicals. Oxygen and peroxide were well known as free radical initiators. UV light was the commonest incorrect answer.

Q.12 (a) “Contact process” and unspecified “combustion” were frequent wrong answers.

(b) Many candidates correctly wrote the expression for K_p , though there was the usual quota of missing pressure symbols, incorrect squaring etc.

Le Chatelier’s Principle was well understood in (ii), though some candidates seemed to believe SO_2 was the product of the reaction, with resultant confusion.

(c) (i) This question generated much creative, though inaccurate, thinking. Nevertheless, many candidates correctly identified the link between increased winter pollution and increased combustion of fossil fuels to provide heating etc.

(ii) Poorly answered, with many candidates simply rewriting the question and not appreciating that a reaction occurs when sulphur oxides dissolve in water.

(d) Nearly all candidates scored at least one mark, though there were many imprecise answers which gained no credit, e.g. “it erodes stones or buildings”.

(e) There was surprising confusion between the Contact Process and the Haber Process in the answers to this question.

Papur Arholiad Cymraeg.

Gwelwyd amrediad o farciau tebyg yn y papurau Cymraeg a Saesneg, gyda marciau yn amrywio o fod yn wael iawn i fod yn ardderchog. Roedd y sgrïptiau Cymraeg hefyd yn debyg i'r sgrïptiau Saesneg o ran safon iaith. Yn anaml oedd yr ymgeiswyr yn gorfod troi at y gair Sasneg, ac roedd eu defnydd o dermau gwyddonol Cymraeg ar y cyfan yn dda iawn, gyda'r ymgeiswyr gorau yn ysgrifennu eu hatebion estynedig, fel cwestiwn 9, gyda graen. Ni welais drafferth gydag unrhyw dermau penodol ar y papurau Cymraeg. Diffyg dealltwriaeth gwyddonol yn hytrach na diffyg deall yr iaith oedd wedi achosi problemau i rai ymgeiswyr.

Welsh Examination Paper

A similar range of marks was seen on the English and Welsh medium papers, with marks ranging from very poor to excellent. The Welsh scripts were also similar to the English scripts in the standard of their language. Rarely did the Welsh candidates resort to using the English word, and their use of scientific terminology was very good on the whole. The best students answered questions requiring extended answers, such as Q.9 with language of a high standard.. I did not come across instances of candidates being unable to understand terms in Welsh. It was lack of scientific understanding rather than language that caused problems for some candidates.

CHEMISTRY

General Certificate of Education June 2006

Advanced Subsidiary

Paper CH3a

Chief Examiner: P. G. Blake, B.Sc., D. Phil., Formerly Senior Lecturer in Chemistry
University of Wales College of Cardiff.

This paper turned out to be satisfactory, with a generally reasonable level of performance but with considerable variation in success in answering different parts of it.

Q.1 Generally very good with good graphs and lines in part (a), the main errors being in inverting the axes (the concentrations should always be on the x-axis), occasional misplotting of points and not using the whole of the grid.

To obtain the whole mark in (b)(i) it was necessary to state that rate increased proportionally with concentration or similar and not merely that it increased; (b)(ii) was almost invariably correct. In (c)(i) the measurement of oxygen evolution by pressure/volume change with the other remaining constant was the only realistic alternative, measurement of the water evolved in aqueous solution not being regarded as a very practical method! The temperature requirement in (c)(ii) was almost always given.

Q.2 This was less good. Considering that most, if not all, candidates had carried out an extrapolation to correct ΔT for losses/gains in Coursework thermochemistry or otherwise in the recent past, it was astonishing how many neglected to do so here. There were also errors of sign, which was of course negative since $T(\text{final})$ was less than $T(\text{initial})$. The calculation in (a)(ii), which was marked consequentially, was mostly correct.

(b) Reasonably well-done in the majority of cases.

Q.3 This split fairly clearly into two with (a) being generally good and (b) generally bad. Most candidates put up a reasonable score in parts (a)(i to vii) with (iv) and (vi) being the least well answered.

In (b)(i) a good number saw that the reading at 20.75 should be rejected, giving a mean of 20.10, but many more just averaged all three without much thought about their dispersion.

The real problem arose in (b)(ii). The mark scheme awarded one mark for calculating the concentration of carbonate and most people got this. Probably the simplest way forward then, given the 1:1 stoichiometry, is via $CV(\text{carbonate}) = CV(\text{acid})$ so that

$$C(\text{acid}) = CV(\text{carbonate})/V(\text{acid}) = 0.100 \times 25.00/20.10 = 0.124 \text{ mol dm}^{-3}.$$

However, what many candidates did was say that there are 0.1 moles of carbonate so that

$$C(\text{acid}) = 1000n/20.1 = 4.975 \text{ mol dm}^{-3}, \text{ ignoring the } 25 \text{ cm}^3 \text{ altogether.}$$

This is where a quick reflection back to the given data should have alerted them to an error. 20 and 25 cm³ are not very different so that the concentrations cannot be very different. Checking whether the answer makes sense is an important technique in examinations that unfortunately is little used.

Q.4 This was thought to be a gift-wrapped four marks for all – quite the reverse!

Clearly, despite the practice in test tube precipitations that most are exposed to, many had no idea at all of what to do. No knowledge of group trends was needed, just an appreciation that the soluble compounds contained a cation and an anion and that some combinations of these in solution would precipitate.

Many tried to use alumina as a source of hydroxide ion and perhaps the nearest miss was to use magnesium sulphate and barium hydroxide; that left the slightly tricky problem of separating magnesium hydroxide from barium sulphate. One ingenious candidate focused on the words “almost insoluble” to wash out the magnesium hydroxide from the barium sulphate and evaporate down. Some of the equation writing was psychedelic.

It is difficult to say just what we should make of this state of knowledge of what in the past has been regarded as basic elementary chemistry.

Conclusion

Taking all questions together a satisfactory result was achieved with some very high marks.

Despite the ups and downs of this paper it performs a useful role and, however imperfectly, attempts to bind theory and practice together.

CHEMISTRY

General Certificate of Education June 2006

Advanced Subsidiary

Paper CH3b/c

Chief Examiner: P. G. Blake, B.Sc., D. Phil., Formerly Senior Lecturer in Chemistry
University of Wales College of Cardiff.

2006 has been another satisfactory year for the AS Coursework with some very high standard performances and with satisfactory equivalence between the, majority, CH3c and CH3b routes. Inevitably, the report focuses on deficiencies and needs for improvement but this should not obscure the generally good work achieved. Many of the points to be made have been made before but, at the risk of tedium, need to be stated again while problems persist.

MALPRACTICE

It is regrettable that in two centres some candidates were found to have worked together on a piece of coursework (identical masses, volumes, write-up) despite both the candidates and the teacher having signed the declaration that it was an individual's own unaided work. The Coursework is an examination like any other and the JCQ notice on coursework of course applies. The penalties for breaking the regulations, which can lead to disqualification from the whole subject, should be made clear to candidates.

TEACHER RESULT SHEETS

Although these are mostly fine, assistant examiners continue to encounter problems of incomplete sheets, incompatible data and lack of clarity. Since 40% of the mark may depend on a comparison of the candidates' results with this sheet, clarity, care and total lack of ambiguity is essential. It is not the assistant examiner's responsibility to attempt to unravel what the teacher might or should have meant.

GENERAL POINTS

Presentation was usually very good with one treasury tag in the top left-hand corner giving security and accessibility. A few obsolete forms or Teacher Result sheets are still being used which can well disadvantage that centre's candidates and not all declarations have been signed.

Quite a few candidates were penalized for excessive use of pencil.

Planning

The aim of the work must be clearly and specifically stated at the beginning of the plan to gain the mark. Again some plans are excessively long (several pages) and contain unnecessary detail which gains no marks.

Implementation and Analysis - see under individual experiments

Evaluation

There are definite signs of improvement here, with a scientific basis being shown and less of “I feel that my results are good”.

Some evaluations of errors are excessively long for an examination and the approach of identifying the main source of error (burette, thermometer, etc.) and using its precision is all that is needed. The errors in pipettes and burettes are very similar so that either could be used as the main source. The estimation of probable error is only a guesstimate so that there is no point in being too fussy.

The weak link still is then applying this to the experimental result to see how many of the numbers emerging from the calculator are of significance. So we still see an error calculated to be say 1% and a concentration then being given as $0.1234567 \text{ mol dm}^{-3}$ instead of $0.123 \text{ mol dm}^{-3}$.

The decimal points vs significant figures battle rages on and at the risk of inducing ennui it is worth stating again that a calculator readout of 0.00143212 expressed to three decimal places (0.001) is rather different from that expressed to three significant figures (0.00143).

The penalties for excessive figures and, the more serious excessive truncation, are given in Circular No. 67, excessive figures being merely messy while excessive truncation destroys information.

A few candidates thought that if one were combining a reading accurate to two sig. figs with one to four sig. figs then the combination would be accurate to six sig. figs; obviously the final result cannot be better than its weakest link. Similarly some thought that taking several readings of a quantity would increase the error rather than the reverse.

There remains the basic difference in approach between estimating error from the likely uncertainties in the equipment used and from the scatter of one's own results. With the small number of determinations here the former is to be preferred.

On a lighter note one candidate stated that accuracy could be increased by stating the result to a larger number of figures.

EXPERIMENTS 1a, 1b and 2

Many very good titrations were seen here in all three experiments, although expt 1a was found to be difficult in one or two cases. Obviously care needs to be taken in respect of CO_2 absorption and expts 1b or 2 may be preferred if this problem arises.

Marks were often lost by (a) not setting up a proper titration table with final reading, initial reading and volume used sections, (b) not giving concentration units, (c) not giving burette readings to 0.05 cm^3 and (d) writing, e.g., 22.5 instead of 22.50.

In expt 2, it must be made very clear if the NaOH is in the burette.

In the Analysis sections some errors were found owing to inversion errors in the calculation of concentration. A simple check is that if more than 25 cm³ of solution A is required to neutralize 25 of solution B then A must have the lower concentration.

EXPERIMENTS 3 and 4

Many good results were obtained but it is necessary to reiterate and amplify points that are causing candidates from a few centres to lose marks unnecessarily.

See also Circular No. 67 of December 2005.

Choice of Experiment

Experiments 3a and 3b, which require the weighing of 0.100 g of Mg metal, should not be used when only two-place balances are available since an immediate uncertainty of 10% is introduced into the result.

Experiment 4 should not be used if only 0.5 degree thermometers are available, unless quantities can be so adjusted that temperature changes are well in excess of 5 degrees, for a similar reason of precision.

Material purity

Again some impure, wet, probably inhomogeneous or even totally wrong solids are being used in a few cases; one centre even managed to get a temperature **rise** with sodium bicarbonate and acid! A solid purporting to be sodium carbonate gave a $\Delta T/g$ of 0.4 degrees as against a usual 2.7. Poorly controlled domestic experiments by the writer using Supercook bicarbonate of soda (best before Jan. 04 2199) with vinegar and with lemon juice both gave ΔT s of -4 degrees with the lemon juice giving a better fizz!

Typical $\Delta T/g$ values for good materials are

Mg around 95, MgO around 15, MgCO₃ 2.6, Na₂CO₃ 2.7 and NaHCO₃ -3.0

None of these chemicals is expensive, sodium bicarbonate being £3/kg and sodium carbonate £10/kg, all are easy to dry and Mg ribbon can be polished up to remove oxide.

Temperature changes

7-10 degrees is ideal and the quantities of acid and solid used can be adjusted to obtain this, notably in expt 4, where $\Delta T/g$ is fairly low and 30 cm³ of acid could be used. Whatever is done, the acid must of course be in a reasonable excess.

There is still some confusion over signs; changes are final value minus initial value so that if the temperature rises, ΔT is positive and vice versa. Possibly candidates would be clearer if a mental connection to changes in their bank balances could be made.

Extrapolation

These have been very variable in quality, some owing more to Salvador Dali than to science.

Extrapolations should of course be back only to the time of mixing, not to the start of the expt, and the extrapolated value should not differ markedly from the highest temperature reached, provided that mixing has been rapid and avoids hot spots, which is an important point of technique.

Rates of cooling/heating differ widely between centres, with those using a nest of three coffee cups in a lagged beaker achieving slow after-changes in temperature and thus easy extrapolation.

Incorrect determination of ΔT from graph

This is not infrequent and could lose a candidate up to 10 marks per graph by reading say 7.2 instead of 8.2 degrees. However the ever-helpful examiners are asked to check the candidate's value on the graph and, if this is wrong, to use the correct ΔT for the Implementation mark and subtract only one mark under Analysis. The need for great care here should however be stressed.

Incorrect number of graphs

In one centre, only one graph was plotted losing the candidates several marks from the scheme; in another, the two experiments were performed in duplicate which is not required.

Miscellaneous points for candidates

1. Make full use of graph paper- do not start at $T = 0$ and thus get a ΔT one inch high on the graph.
2. Record masses to full precision of the balance, i.e., 0.100 g, not 0.1 g.
3. Weigh out masses within the range instructed.
4. Sign of ΔT and relation to sign of ΔH . Still much confusion with candidates going all round the houses but not saying the key words that if one is positive in sign the other is negative. The words exothermic and endothermic are not needed being tautologous with the sign of ΔH . The concept is not entirely straightforward owing to the idea of system and surroundings, but, if ΔH is negative, the reacting molecules (the system) lose energy to the water (the surroundings) which heats up so that ΔT is positive.

Neglecting any of these points loses a mark.

EXPERIMENTS 5 AND 6

These were usually free from serious problems and gave some excellent straight- line graphs in many cases.

Sources of mark loss included (a) poor significant figures in concentrations or volumes such as 2 cm^3 rather than 2.0 cm^3 , and in the reciprocals of time, (b) graphical errors- inversion of axes, no title, no axis label, starting graph at 0/0 with consequent poor use of space, no units, (c) not clearly stating that the rate is directly proportional to concentration.

Also, not discussing the need to control variables in the Plan, using too narrow a concentration range for the runs or times that are too short and not dealing with all three parts of the Evaluation section.

In conclusion, and despite all the above, candidates and teachers are to be congratulated for their sterling efforts in 2006.

CHEMISTRY

General Certificate of Education January 2006

Advanced Level

Paper CH4

Chief Examiner: D.H.Ballard, B.Sc., Ph.D., C.Chem., F.R.S.C.
Lecturer in Science Education, Nottingham Trent University

General Comments

This paper is taken mainly by candidates during the second year of their two year A Level course and the cohort for this paper was similar to previous examinations.

The range of marks gained by the candidates was again very wide with a few candidates scoring around 70 out of 75.

A trend in recent papers is to introduce candidates to unfamiliar compounds and get them to apply their knowledge of the functional group chemistry they have learnt in this module. Most candidates realised that you should seek out the respective functional group and deal with this as a separate entity.

Spectroscopy continues to be important feature of organic chemistry and there was evidence that candidates are becoming more used to using both infrared and NMR spectroscopy as part of analytical work

There is still a continuing problem with the balancing of equations and candidates are reminded that all reactants and products should (normally) be shown..

There was evidence that the paper kept candidates working to the end of the allocated time and perhaps some candidates did not spread their time evenly throughout the paper. It was not clear, however, whether an unfinished Question 5 was because of shortness of time or the inability to answer parts of the question.

The examiners felt that those questions requiring calculations proved more challenging in this examination than in recent papers, as there was more of an element of interpretation in the question, particularly in Question 5.

Section A

- Q.1 (a) (i) The question asked for the name of the compound. Those who gave the formula gained no credit, as an element of the question was to deduce the formula and hence the name. Some (carelessly) gave pentene instead of pentane.
- (ii) The meaning of the word 'heterogeneous' was generally correct.

- (iii) Overall, the responses to the mole calculation were weak. A number of candidates used propene instead of propenoic acid. Some did not take into consideration that the yield was only 90%.
 - (b) In a number of cases, water was missing from the equation.
 - (c) The question required candidates to draw the formula of the addition polymer, given the formula of the monomer. This was really an AS question but the response was disappointing with many errors being seen.
 - (d)
 - (i) Most knew the difference between addition and condensation polymers but not all candidates described both in their response.
 - (ii) The question was about polyesters but many candidates indicated the two bifunctional groups necessary to make a polyamide.
 - (e) The reagents necessary for hydrolysis were generally known but not all those whose chose the alkaline route then mentioned the necessary acidification.
 - (f) Some people who chose LiAlH_4 as Reagent **E** had difficulty in naming it correctly, although some latitude was allowed.
- Q.2
- (a)
 - (i) Most candidates knew that the alkene group would decolourise bromine. A few candidates still stated that the bromine would go from brown to clear. Some believed (wrongly) that piperitone was an aromatic compound and that bromine water would also give a white solid. Piperitone does not react with Tollens' reagent and this was stated by nearly all candidates.
 - (ii) The reagent for the reduction of the keto group was well known as was the reagent and catalyst for the further conversion to menthol.
 - (iii) The reaction of iron(III) chloride with a phenol was generally given correctly but the bromination of thymol proved challenging. Substitution anywhere in the ring was accepted but side chain bromination was not awarded credit. Some candidates believed that the phenolic OH group was replaced by bromine.
 - (b) The answers to the NMR question were generally rather poor. The most common response was to state that compound **J** was butylbenzene but unfortunately consideration of the NMR spectrum would have indicated that all protons were equivalent with no protons attached to the adjacent carbon atom. The only correct compound was 2-methyl-2-propylbenzene. Only the formula was required but only the most able candidates could reach this conclusion.

- Q.3 (a) (i) The reason why butylamine acts as a base was well known.
- (ii) The examiners saw some disappointing responses to the diagram to show butylamine and water undergoing hydrogen bonding. Some responses included curly arrows and some had polarities wrong, in this AS style question.
- (b) This question looked for an element of free response in the answer. All too often the answers were disjointed and illogical, which made marking difficult. Aqueous solutions were kept at 50°C whilst being refluxed, and nitrous acid was producing zwitterions ! Some fine responses were seen, however, and candidates should note that the emphasis of the question was on conditions and observations, and only the best responses addressed these points.
- (c) (i) The term chromophore was an easy mark for most candidates. In II, many candidates gained some credit but it was necessary to link wavelength, frequency **and** energy to gain full marks.

The reagents and observation for the iodoform test were required in part III. Some candidates gave KI and NaOH as the reagents, but an oxidant is necessary for success. A few confused themselves (and the examiners) by mentioning iodoform as well as NaOH / I₂ in the reagent response. It was not always clear whether iodoform was meant to be a reactant and the examiners had to best guess here.

Section B

- Q.4 (a) (i) Although many candidates gave homolytic fission as the bond breaking process, the radical was seldom correct. The reaction sequence indicated that a 2-butyl radical was necessary, all too often a 1-butyl radical or a 2-butyl carbocation was given.
- (ii) The mass spectrum of 2-chlorobutane gave peaks at *mass / charge* values of 92 and 94. Very few candidates indicated the isotope of chlorine responsible for both and many lacked the positive charge. Even fewer appreciated that the dichlorobutane needed to have two chlorine atoms both of isotopic mass 35.
- (iii) Candidates fared better with the alkaline hydrolysis of 2-chlorobutane and many correct responses were seen. The examiners felt that the use of curly arrows was much more precise than in recent examinations.
- (iv) The reagents for the oxidation of butan-2-ol were usually correct. However, although most candidates gave the correct IR absorptions for butan-2-ol and butanone by use of the Data Sheet, the question asked how these would change during the reaction. There were fewer candidates who were able to describe this successfully.

- (b) (i) The zwitterion structure was usually correct but there were some interesting (wrong) variations !
- (ii) Most candidates knew that a base abstracted a proton from the zwitterions but a number of responses stated that hydrogen was lost.
- (iii) Many candidates gave the formula for the dipeptide correctly.
- (iv) The usual test given for a ketone was the test using 2,4-dinitrophenylhydrazine and many candidates tested for the carboxylic acid with a carbonate or hydrogencarbonate. (The term sodium hydrogen carbonate is wrong but it was common to see this). Most then used lime water to identify the carbon dioxide evolved.
- (v) The reagent for the reduction of the aldehyde was well known but some candidates did not realise that decarboxylation is a way of descending the homologous series and that the answer was ethane not propane.
- Q.5 (a) (i) Compound **Y** was ethylbenzene but many candidates did not use **all** the information as required to deduce the compound. The use of the NMR was adequate but often expressed poorly.
- (ii) Many candidates believed that acidified (rather than alkaline) manganate(VII) would oxidise the side chain group **R**, but this too gained some credit. The calculation was often muddled, with the mass of one compound being related to the M_r of the other compound.
- (b) (i) Some candidates did not give the sodium salt of the acid in their equation. The purification of benzoic acid proved troublesome for a number of candidates. It was obvious that some centres had prepared their candidates very well for this type of question but many candidates from elsewhere were floundering and picked up odd marks here and there.
- (c) The alkaline hydrolysis of the substituted acid chlorides was a variation on a theme that has often been asked. Most candidates gained some credit but only a few candidates gave really clear answers and correct formulae.
- (d) Many candidates could give an adequate explanation for the colour of an azo dye but the response was poorer when they tried to explain the appearance of the red line in the Balmer series. However, it was rare to see an answer that could not be awarded any marks.
- (e) Perhaps it was because this was at the end of the paper, but the responses for this question that related ionisation energy and the Lyman series were often unconvincing. This is a section that is difficult to explain clearly and, as a result, becomes difficult to mark!

CYMRAEG

Marciodwyd 36 o sgrriptiau (6 o'r rhai hynny yn uniaith Saesneg).

Yn gyffredinol, er gwaetha'r sampl llai o bapurau cyfrwng Cymraeg i gymharu â'r Saesneg, nid oedd unrhyw wahaniaeth arwyddocaol yn ymatebion yr ymgeiswyr. "Roedd y safon ieithyddol yn debyg iawn yn y ddwy iaith, er bod lleiafrif o'r ymgeiswyr Cymraeg wedi defnyddio ambell derm Saesneg yn eu hatebion. Dylid nodi'r ffaith bod angen defnyddio termau gwyddonol manwl-gywir i ennill marciau, pa bynnag iaith a ddefnyddir. Yn arbennig, dylid nodi'r ateb cywir i C2 (a) (ii) IV "mae enantiomer yn cylchdroi (troi) golau plân polar". Mae'r termau "troelli", "plygu" a "newid cyfeiriad" yn anghywir. Hefyd, yn C5 (ch) a (d), dylid sicrhau bod y myfyrwyr yn deall y gwahaniaeth rhwng y termau "trawsyrru / adlewyrchu" ac "allyrru".

36 scripts were marked (6 of those entirely in English).

In general, despite the smaller sample of Welsh compared to English medium papers, there was no significant difference in the students' responses. Their linguistic skills were similar in both languages, although a minority of the Welsh candidates used an occasional English term in their answers. It should be noted that precise scientific terms are required in order to gain marks whatever the language used. In particular, it is important to note the correct answer to Q2 (a) (ii) IV "an enantiomer rotates (turns) plane polarised light". The terms "spins", "bends" and "changes directions" are wrong. Also, in Q5 (d) and (e), students should be made aware of the difference in meaning between the terms "transmits / reflects" and "emits".

CHEMISTRY

General Certificate of Education June 2006

Advanced Level

Paper CH5

Principal Examiner: M. E. Anthony Ph.D.

General Comments

There were 1437 candidates sitting this paper, of whom 98 did so through the medium of Welsh, figures very close to last year's entry. The mean mark was 37.0 (maximum 75), an increase of 4.4 on last year and the highest value for several years, with standard deviation 14.5.

There was no evidence of candidates having inadequate time to attempt all the questions. While some questions were challenging and discriminating, nearly all candidates were able to attempt most questions and there were no dead marks.

In contrast to recent years, candidates scored more heavily on Section B than Section A, with the inorganic analysis (Q1) and pH titration (Q3) questions being, by some distance, the most poorly answered questions. Presumably through the demise of time and facilities for practical work, too few candidates seemed to have actually experienced the rigours of laboratory based analysis and guesswork was prevalent in the suggested observations. Other traditional problems also remain: there was a general lack of appreciation of what constitutes a description of an observation (e.g. "HCl was evolved"), writing correct balanced equations was beyond the capabilities of very many, and in Q3, many answers showed an unwillingness or an inability to process the information provided in the question, and there was a general air of uncertainty as candidates constructed answers based on tenuous mathematics. On the positive side, this year showed an improvement in answers to calculations being given to an appropriate level of precision.

Despite repeated reference to this in previous reports, several candidates were allowed to write answers in pencil.

Detailed Comments

Section A

- Q.1 (a) (i)&(ii) Marks were often lost here through omission rather than inaccuracy, with most content to give a single statement regarding the observation, e.g. “misty fumes”. Top quality answers which followed the exemplar such as “lilac colour in flame” were rare and a minimalist approach was common with the single word “lilac” given. The most common mistake was to give lithium rather than calcium as the cation with orange-red flame colour. In (ii), the failure of sodium hydroxide to redissolve the magnesium hydroxide precipitate was only rarely stated. Several candidates seemed to hedge their bets and give white precipitate for all observations. Many realised that zinc sulphate and barium nitrate produce a white precipitate but failed to make the link in the next line and were unable to identify the compound as a sulphate; chromium was rarely given.
- (b) There were many fictitious reactions and blanks where there should have been balanced equations. In part (ii), the idea of ‘amphoteric behaviour’ was not well understood, with many candidates attempting to give redox reactions rather than acid-base ones. Part (iii) was done most successfully with the industrial reactions of carbon monoxide with iron oxide or steam being the favourites.
- Q.2 (a) (i) There were very few correct answers for what should have been a simple explanation of rate of reaction. Most made no mention of “concentration” and vague statements such as “the time taken for products to form” were prevalent.
- (ii) The vast majority of candidates were able to determine the correct values of x & y.
- (iii) Many were able to suggest that hydrochloric acid acts as a catalyst but then failed to obtain the second available mark. Most gave an account of a catalyst lowering the activation energy or some other obtuse explanation and failed to link the stoichiometric and rate equations.
- (b) (i) This was done quite well though several were not able to rearrange the expression for k.
- (ii) It seemed that many guessed at the answer to this part although there were some well expressed answers linking the rate limiting step with the rate equation.
- (c) (i) There were very few sensible answers. Where some attempts to puzzle out an answer were made they often resulted in unacceptable conclusions such as the pH of weak acid does not change sufficiently or, more worryingly, many described methanol as an alkali.

- (ii) On the face of it, this should have provided an easy mark for students but many gave names of equipment rather than a brief description of a technique or answers that were too vague to gain credit (e.g. “measure the gas” or “temperature”). Many answers to (c) (i) & (ii) suggested that candidates did not understand what is meant by “studying the progress of a reaction.”
- Q.3 (a) (i) This was correctly done by many candidates, but expressions for the equilibrium constant, K_a , using the titration equation supplied turned up with alarming frequency.
- (ii) There were many inaccurate and simplistic statements of pH such as “how much acid or alkali there is.” Candidates from a significant number of centres produced long, convoluted, narrative answers when trying to explain pH instead of the conventional $\text{pH} = -\log[\text{H}^+]$, but then used the correct expression in part (a)(iii) but because of the imprecise wording used in the narrative, the mark could not be awarded retrospectively.
- (iii) The most common mistakes here were failing to calculate the square root (even when it was shown explicitly in the workings) and substituting the value for K_a directly into the expression for pH.
- (b) (i) This was done really badly. Some did not link this to their answer in (a) (iii) and very many could not identify the start of the titration. Crosses appeared haphazardly on the graph..
- (ii) & (iii) Answers in many cases indicated that candidates did not know what is meant by the term “end point.” Values for both pH and volume were taken from a variety of locations on the graph, many giving 28.0 cm^3 for the volume.
- (iv) Several candidates who could not identify the end point in (iii) were now able to use the correct value of 20.0 cm^3 in calculating the concentration. Some were able to gain marks consequentially on incorrect answers in (iii). However, the general standard for this answer was poor. Some absurd values of 10^{-13} were suggested as a result of using the expression for the ionic product of water. There were several instances of candidates persisting with the use of M in place of mol dm^{-3} .

- (iv) Most candidates were able to gain some credit on this part. However a great many selected what they thought was the best indicator rather than all those which would be suitable. Only one answer was given as a consequence and half a mark was lost. Many candidates struggled to find unambiguous phrases to convey their understanding of the shape of the pH curve. Instead of describing the key region of the curve as the “inflexion” or “steep section” or “the region where pH changes rapidly upon the addition of small volumes of alkali”, meaningless phrases such as “the end point range” or “pH range for the end point” were all too common.

Section B

Q.4 Candidates responded well to this question and some really excellent answers were received on most of the sub-sections.

- (a) Most candidates were able to give correct electron configurations.
- (b) Many struggled to express themselves and gave poorly worded answers. Several confined their answers to iron ions and commented only on the stability of Fe^{3+} . General reasons for more than one oxidation state were not well known.
- (c) There were some well expressed answers for both parts with many candidates showing good understanding of these topics. In (i), there were several answers incorrectly based on polarisation and intermolecular forces. In (ii), the origin of colour in complexes was quite well known. Some failed to gain marks by ignoring the role of the ligand in causing the d-orbital splitting and others neglected to mention the 3:2 split characteristic of an octahedral field. A few answers showed confusion with emission spectra.
- (d) (i) Most candidates did quite well on this part.
- (ii) This continues to be a topic that students have difficulty in describing accurately. The best answers calculated cell e.m.f. and described feasibility on the basis of its sign. Answers which attempted to discuss oxidising / reducing ability often resulted in confusion. Some made comparisons between the Fe & Ag half equations and ignored the oxygen system and nonsense statements such as “oxygen is a stronger oxidising agent than Fe” were prevalent. Weaker students frequently failed to distinguish between the metals and their ions. Stating in simple fashion that one value for E (half cell) is bigger / larger than the other is insufficient to gain credit.
- (iii) Only a few candidates were able gain full marks on this, with many woolly, imprecise answers. While the concept of comparison with the standard hydrogen electrode was quite well known, many failed to define standard conditions and very few discussed the significance of the value being a reduction potential.

- (e) (i) Many candidates gave correct solutions to this calculation. A value of -186.0 was not required for full marks, despite the data in the question justifying this level of precision. Predictably there were many answers with the wrong sign and there were others with omission of one or more of the multiplication factors.
- (ii) Many candidates were able to predict Fe^{3+} correctly and provide an impressive explanation. Some omitted to suggest a reason, essential to gaining any credit and others completely ignored the previous parts to the question, hence failing to gain full marks.

Q.5 This question also proved popular, with part (a), in particular, being well answered.

- (a) (i) Poor expression often lost marks in this part. It was common to see “aluminium chloride (or “it”) only has 6 electrons in its outer shell” when the candidate was clearly intending reference to the Al configuration.
- (ii) While most gained credit for this, there were several diagrams which did not show the coordinate bonds and others which had the arrow direction reversed or showed them in an unconventional fashion.
- (iii) A surprising number failed to give the correct formulae of the ions, with many answers such as Cl_3^- instead of 3Cl^- .
- (b) Again, poor expression resulted in failure to gain full marks. “Nothing was observed” was a common and inadequate substitute for “The liquids did not mix and no signs of reaction could be observed”. Nevertheless, the majority seemed to appreciate the fact that tetrachloromethane does not react with water whilst tetrachlorosilane does, even though accurate descriptions of observations were not forthcoming. Differences in behaviour were not well described and a significant number of candidates were of the opinion that carbon does not have d orbitals. Explanations based solely on the relative sizes of the CCl_4 and SiCl_4 molecules were not accepted.
- (c) (i) The shapes of the phosphorus chlorides were not well known or well deduced with the trichloride suffering more. Trigonal planar was invariably the wrong description.
- (ii) Most candidates were able to predict correctly that low pressure is required, but concise reasons based on movement of the position of equilibrium were rare. A few suggested that high pressure would cause the molecules to break up.
- (iii) Most candidates were able to give a correct expression for K_p with only a few using square brackets or showing it “upside down.”
- (iv) Many candidates were able to calculate the required value. Some gave 0.087 suggesting they confused 3 sig. fig. with 3 decimal places. Some omitted units whilst others unnecessarily converted atm. into Pascals. A worrying minority were able to write the correct expression and substitute into it but failed to rearrange it properly.

- (d) There were some nicely written answers to the final question, but very few candidates obtained the maximum five marks. Many struggled to recall the facts or make the comparison requested in the question. Often, time was wasted discussing the trends within a group, sometimes exclusively, sometimes alongside the correct comparison. A common omission was the failure to mention oxygen as a product of the thermal decomposition of nitrates. Most candidates made the correct comparison of the solubility of the carbonates, but several described the formation of a precipitate when magnesium carbonate is added to water. There was much confusion regarding the thermal stability of hydrogencarbonates.

Papurau Cyfrwng Cymraeg

Mae safon yr iaith ysgrifenedig a ddefnyddir gan yr ymgeiswyr yn dal i wella yn flynyddol a rhaid eu llongyfarch am eu parodrwydd i ddefnyddio terminoleg astrus mewn modd cywir a darllenadwy. Mae'r sylwadau uchod parthed y pum cwestiwn yn lawn mor berthnasol ar gyfer yr ymgeiswyr cyfrwng Cymraeg ond dylid talu sylw i'r materion ychwanegol dilynol: Roedd gormod o arwyddion o ddiffyg dysgu gwaith yn drwyadl ymysg y papurau a farciwyd. Collwyd marciau pwysig gan ymgeiswyr galluog (gwelwyd hyn yn arbennig yng Nghwestiwn 1) oherwydd bod y ffeithiau sylfaenol heb eu dysgu ac fe anogir Canolfannau i bwysleisio hyn gyda'r ymgeiswyr i'r dyfodol. Cafwyd ambell enghraifft o ymgeiswyr cyfrwng Cymraeg yn camddarllen cwestiynau ac, o'r herwydd, yn cynnig atebion anghywir. E.e. Cwestiwn 2 (c) (i) – roedd amryw wedi camddarllen y cymal “pam na fyddai mesur pH yn dechneg addas” ac wedi ceisio ateb fel pe byddai'r cwestiwn wedi gofyn y gwrthwyneb. Hefyd Cwestiwn 5(ch) lle roedd amryw wedi meddwl fod y Metelau Grwp 1 a Grwp II yn adweithio gyda nitrad(V) solet. Dylid pwysleisio (unwaith eto) i'r ymgeiswyr i ddarllen y cwestiynau'n drwyadl. Cofier fod colli marciau yn U2 Papur CH5 yn gallu effeithio'n fawr ar yrfa Coleg a'r graddau ar gyfer cael mynediad. Trist o sefyllfa yw'r un lle gwelir marciau'n cael eu colli trwy ddiofalwch neu drwy ddiffyg dysgu ffeithiau.

Translation

The standard of written Welsh used by the candidates shows an year-on-year improvement and the candidates are to be congratulated on their willingness to use complex terminology in a clear and readable manner. The above comments on each of the five questions are equally applicable to the Welsh medium candidates but attention should be paid to the following specific points: Amongst the question papers marked, there were far too many examples of facts not being thoroughly learnt. Able candidates (especially in Question 1) were losing important marks because basic facts had not been assimilated and Centres are asked to remind candidates of the importance of thorough revision and the learning of core chemical facts. There were some examples of Welsh medium candidates mis-reading questions and, as a result producing incorrect answers. E.g. in Q2 (c) (i) the question stated “why the measurement of pH would not be a suitable technique” but candidates read it as the exact opposite. Also in Q5(d) many candidates insisted on describing reactions of Group I and Group II metals with nitrate(V) compounds. Reading questions thoroughly should (yet again) be emphasised as being good practice. Candidates should be reminded that losing marks at A2 CH5 can affect grades and subsequently entry to Higher Education courses. It is a sad situation when such marks are lost through carelessness or through insufficient revision prior to the examination.

CHEMISTRY

General Certificate of Education June 2006

Advanced Level

Paper CH6a

Chief Examiner: Elfed Charles

General Comments

It was felt that although the synoptic paper covered a wide range of the syllabus, it was accessible with some differentiating questions that tested the most able. There was no evidence of insufficient time to complete the paper. There was a good spread of marks, only about 40 candidates scored less than 10 out of 50 while about 70 candidates scored 40 or more.

As a whole, Q4 was answered best, with Q1 being the least successfully answered. The easiest parts on the paper proved to be Q3(a), Q4(a)(ii)II and Q1b, while the hardest parts were Q1(c)(ii), Q1(a)(ii) and Q3(d)(i).

The calculations were generally well done, with Q1(b) and Q2(g) being two of the best answered parts of the whole paper. Although a minority still did not understand the concept of significant figures, it was pleasing to note that there was an improvement in the correct use of significant figures.

Many candidates were able to write simple inorganic equations, Q1(a)(i) and Q2(c). However writing an organic equation, Q3(b), proved far more taxing and the recollection of organic reagents and conditions was poor.

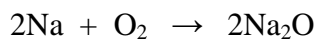
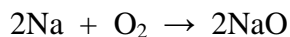
Another area which continues to be a cause for concern is intermolecular bonding, Q2(e). Finally, as seen in other papers, many candidates had difficulty in expressing chemical ideas and principles when required to write explanations.

Papur Arholiad Cyfrwng Cymraeg

Roedd safon yr iaith a ddefnyddiwyd gan yr ymgeiswyr cyfrwng Cymraeg yn uchel ar y cyfan. Eithriad prin iawn oedd ymgeisydd yn defnyddio term neu air Saesneg a chalonogol iawn yw gweld dros y blynyddoedd sut mae'r safon iaith wedi gwella. Roedd safon y goreuon yn dda iawn a braf oedd gweld atebion mor dda yng nghwestiwn 4(b) lle roedd gofyn am ddefnydd o iaith estynedig. Roedd y camgymeriadau yn gyffredinol i'r ymgeiswyr cyfrwng Saesneg yn ogystal â'r ymgeiswyr cyfrwng Cymraeg.

Section A

- Q.1 (a) (i) The equation for the reaction between sodium and oxygen was meant to be an easy starter and this proved to be the case for about two thirds of the candidates. the most common incorrect answers were:



- (ii) Poorly answered. Only a few gave an explanation in terms of lattice and hydration enthalpies. About a third of the candidates gained some credit for explanations in terms of dipolar forces. Many answers were insufficient, e.g. “they form ions which are surrounded by water molecules”, while others were completely incorrect, e.g. “they form hydrogen bonds with water”.
- (b) The Born-Haber cycle was well known, with the majority gaining all 4 marks. Most candidates who gave an incorrect answer still obtained some credit for the cycle.
- (c) (i) Just under half of all candidates obtained both marks. Most incorrectly gave -10 kJ mol^{-1} as the answer.
- (ii) Easily the worst answered part on the paper. Only about 1 in 10 candidates correctly stated that the Rb^+ ion was larger than the K^+ ion. Some lost the mark by incorrect use of charge density, but the vast majority lost the mark by using the terms ‘atoms’ or ‘molecules’ instead of ‘ions’.

Section B

Q.2 This was a comprehension question on a short passage about hydrogen sulphide.

- (a) Only about a quarter of the candidates gave a correct explanation. Most candidates merely copied the reference to hydrogen sulphide being intolerable at 1ppm without expanding on it.
- (b) This proved to be a difficult calculation. The vast majority could not change 1 mg into moles.
- (c) Well answered, with about two thirds giving a correct equation. The main errors were writing FeS as Fe_2S or FeSO_4 .
- (d) (i) Again well answered. Most candidates knew that the shape of the hydrogen sulphide molecule was ‘bent’. However, a significant minority incorrectly insisted on calling the shape ‘bent linear’.

- (ii) Disappointingly answered. Only about a quarter of the candidates obtained both marks. Some candidates lost a mark for giving one lone pair of electrons instead of two. Others lost a mark for failing to express themselves clearly, e.g. “the lone pairs repel the hydrogen atoms away” or “due to electron pair repulsion theory, they arrange themselves as far away from each other as possible”.
- (e) Fairly well answered. The vast majority gained some marks in this question. However, many marks were lost due to poor language skills and chemical misconceptions, e.g.:
- failure to state that hydrogen bonding takes place between molecules
 - failure to compare the strength of the intermolecular bonding
 - strength of hydrogen bonding decreases down group VI hydrides
 - covalent bonds in H₂S weaker than hydrogen bonds in H₂O
 - boiling temperature of H₂S greater than that of H₂Se due to increased dipole.
- (f) Very well answered, with about 3 in 5 candidates getting both marks. Some lost the marks since they did not follow the instructions and explained redox in terms of electron transfer.
- (g) Again, very well answered, with about 3 in 5 candidates scoring full marks. Main errors were incorrect calculation of copper(II) sulphide’s molecular mass or failure to give the answer to three significant figures.

Section C

- Q.3 (a) (i) Easiest mark on the paper. Only a few candidates failed to get the mark. The vast majority chose the direct hydration of ethene as being more environmentally friendly despite the damage made to the environment in producing ethene in the first place!
- (ii) Well answered. Over half gained both marks and a further quarter gained one mark. Despite knowing the general conditions, some candidates lost the marks since they did not give any reasons.
- (b) Poorly answered. The majority either did not know the products of combustion of ethanol or they omitted the oxygen as a reactant.
- (c) (i) About four fifths of candidates correctly stated that the colour change was from orange to green. The incorrect answers were mainly either stating green to orange or just green.
- (ii) Just over half the candidates managed to give the correct half equation.
- (iii) Proved to be a good discriminator with only about a quarter getting both marks. A further 1 in 5 gained one mark by getting the reactants and products correct but failing to balance the equation.

- (d) Poorly answered on the whole. Candidates seem reluctant to learn facts such as reagents and conditions for organic reactions.
- (i) Only about 1 in 10 could recall that concentrated sulphuric acid must be added to sodium bromide to produce hydrogen bromide. Another 25% of candidates gained some credit for giving sulphuric acid.
 - (ii) Naming compound A as bromoethane was not a problem for almost all candidates. However, only about a quarter could correctly identify compound B as propanenitrile.
 - (iii) Again, the reagents and conditions for converting bromoethane to propanenitrile were not well known. Only about a third knew that potassium cyanide was the reagent and only half of these knew the correct conditions.

Q.4 This was the best answered question as a whole on the paper.

- (a) (i) This question asked candidates to identify the structures of 5 organic compounds from given data and over a third obtained all 5 marks.

Some marks were lost due to writing sloppy structures, e.g. omitting hydrogens from the chain or a carbon being bonded to the hydrogen instead of the oxygen in an acid or alcohol, or not reading the question properly and giving branched chain isomers.

Compound A, pentyl propanoate, proved to be the hardest to identify with less than half giving the correct structure. The commonest error was to give a very long acid.

Compound D, ethane, was the next hardest, although about 60% correctly identified it.

The other compounds – propanoic acid, pentan-1-ol and pentanoic acid – were very well identified.

- (ii) I Well answered - about 60% gave a correct structure.
- II Very well answered, with about 9 in 10 giving the feature required for a molecule to show optical activity. Some candidates spoiled their answer by stating that a carbon was attached to four different molecules.
- (b) This part required the candidates to describe the structure and bonding in benzene and to explain the difference in reactions of benzene and ethene with electrophiles.

A number of good answers were seen where candidates fully described the bonding as well as the structure and explained the difference in the reactions, not merely stating the types of reaction.

Candidates did not have to state all the features of the structure and bonding to gain the full marks for this part and marks could be gained by drawing a diagram. The main reasons for failing to gain full marks were failure to mention the carbon – hydrogen bonds, failure to describe the origin of the delocalised π – electron system or omitting the π .

In the explanation part, many gained a mark for describing electrophilic addition across the double bond in alkenes. However, most candidates simply stated that benzene reacted by substitution or described a substitution reaction. Only the better candidates explained that, in benzene, addition would result in a disruption of the delocalised π – electron system.

CHEMISTRY

General Certificate of Education June 2006

Advanced Level

Paper CH6b/c

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Introduction

It had been another satisfactory year in this welcome, if temporary, period of assessment stability with some very impressive high-quality work from some candidates. Most centres again took up the 6c option.

General Comments

The most popular experiments were I1, I3, O1 and O3 with I2 and I4 having some followers.

Three-place balances are still not available in some centres, thus restricting the inorganic choices to I3 and I4.

Problems of poor yields in the organic experiments are fewer this year, but it is worth restating that the main cause of this seems to be the working up of the crude product, when too much solvent is used in recrystallisation in a vain attempt to dissolve non-product impurities. Obviously some judgement is needed here, but when most of the solid has dissolved and addition of a little more hot solvent seems to have no effect it is time to stop addition and filter.

In experiments involving unknowns, there should be differences in what is given to different candidates and what has been given must be crystal clear to the examiner, using the letter system indicated. In one centre, a number system was used, causing considerable difficulty. In general, however, Teacher Results Sheets were clear and unambiguous.

Synoptic questions were generally well-answered although, again, the distinction between a description and an explanation was not always understood.

Loss of precision through incorrect rounding-up and loss of significant figures continued to surface in some cases, especially in inorganic experiments.

No rough work or instruction sheets should be included.

Individual Experiments

- I1** Usually good, but sometimes with lower marks on the first titration than the second and mark loss through improper rounding up and loss of significant figures. In the questions, marks were often lost in Q1, Q2 and Q6 through vagueness or lack of clarity
- I2** Generally well done with no particular problems.
- I3** The approach was usually correct but the plan needs to be spelt out, the colour of precipitates must be given, equations for reactions that do not occur are penalized and magnesium sulphate and sodium carbonate were sometimes confused.
- I4** More popular this year. Quite a difficult exercise and the sample plan in the Guidance Notes could be helpful.
- I5** This was usually well-done. It is worth restating that a small overshoot in part A will introduce a sizeable error into part B owing to the 5:1 ratio, that iodide should only be added immediately before a sample is titrated to avoid air oxidation and that no cube root calculation is needed in Q8.

I6/I7 These were little-used.

- O1** Most chose part A and results and yields were usually satisfactory. There were, however, often weaknesses in the questions. In Q1 and Q3 oxidation states are still being written incorrectly as if they were charges on ions, i.e., Mn^{7+} , i.e., 7+ rather than +7 or +VII or 7. Note that conventionally a plus sign is not necessary for positive quantities. Equation writing in Q1(b) and Q3(b) was sometimes poor.

Test 4 continues to baffle some. A buff, or similar coloured, precipitate (of Fe benzoate) is observed in (i) that dissolves in the acid in (ii) to leave white precipitate (of benzoic acid).

In Q7, the reagents used in the tests must be described as well as the test results and explanations; it is not enough to say “use Tollens reagent”.

O2 No problems

O3 Several comments can be made concerning this popular experiment.

The plan must be a real plan, whether written as a flow chart or extended prose, in which the sequence of tests is important and not just a list of reactions undergone by the compounds. Mini organic textbooks or internet downloads are not wanted.

Marks are often lost by omitting equations and these should be specific to the compound and not generic (i.e., not RCOOH etc).

Too much reliance should not be placed upon physical properties, although these are useful in confirmation.

Amides can cause confusion; they are not acidic and like amines will react with nitrite/acid so that this test is confirmatory only for amines.

- O4** Little used
- O5** No particular problems but the comment above concerning low yields is relevant here where relatively insoluble poly-substituted products may be formed in coupling so that excess solvent may inadvertently be used in recrystallisation.
- O6** No problems
- O7** In Q3, replace “phenylamine” with “phenol”. In the tests candidates should note the solubilities of the acids in both cold and hot water.

Conclusion

A solid performance by all concerned.

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