Review of Standards in GCE A level Chemistry

2003 and 2008

April 2012

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Contents

Executive summary

The Office of Qualifications and Examinations Regulation (Ofqual) undertakes a rolling programme of reviews across high-profile GCSE and GCE A level subjects to monitor whether standards in assessment and student performance have been maintained over time.

This report details the findings for GCE A-level Chemistry in the years 2003 and 2008. The previous review for this subject compared the years 1999 and 2003 and was published in 2005 www.ofqual.gov.uk/files/12890_chemistryreport.pdf .

The review compared subject specifications, assessment materials and student work from the five awarding organisations offering this qualification in the years being reviewed by collecting the views of a number of subject specialists. The awarding organisations involved were AQA, CCEA, Edexcel, OCR and WJEC.

Findings

The subject criteria were common to both years studied in this review, and specifications showed few changes. Because of this, any significant changes over time were due to differences in the questions being asked in assessments. The review found the specifications became less demanding between the two years due to differences in the way questions were structured. In 2008 there were more short-answer questions, involving simple recall, and fewer questions that required students to formulate multiple-step responses. This resulted in able students having less opportunity to demonstrate their higher-order knowledge and thinking skills in their responses to questions.

Section 1: Introduction

Context

We regularly review qualifications in different years to check that standards are maintained over time.

These reviews inform future developments in qualification and subject criteria and help us to compare standards across awarding organisations. In our reviews, we:

- analyse the nature of the requirements different assessments make on students
- compare the levels of performance required for a particular grade in different assessments
- consider how these two elements relate to each other.

This review was carried out in 2011 based on materials collected from the years 2003 and 2008. Between 2003 and 2008, there was an increase in the number of students that took the GCE A level Chemistry specifications being reviewed. In 2003 6,453 students took the A level and in 2008 36,468. A detailed breakdown of student-entry numbers and cumulative percentage pass rates can be found in Appendix F.

Our immediate predecessor, the Qualifications and Curriculum Authority (QCA), most recently conducted a standards review in GCE A level Chemistry, using materials from 1999 and 2003. The findings were published in a report in 2005, which is available on our website at www.ofqual.gov.uk/files/12890_chemistryreport.pdf.

Methodology

Standards reviews examine different specifications within a qualification, the associated assessment instruments and samples of student work, by collating and analysing the views of a number of subject specialists. The following sections of this report detail the process of collecting and processing this information. In these reviews, we compare how demanding a specification is against all of the other specifications under review and includes consideration of:

- specification-level factors such as assessment objectives, content and structure
- assessment-level factors such as what content is assessed, the weighting of each component and how the assessments are marked
- student performance-level factors, including how the students responded to the assessments and the grades they received as a result.

How demanding an assessment of a qualification is can be defined in a variety of ways and is linked to the purpose of the qualification. It is related to:

- the amount and type of subject knowledge required to be assimilated
- the complexity or number of processes required of the students, the extent to which the students have to generate responses to questions from their own knowledge, or the extent to which resources are provided
- the level of abstract thinking involved
- the extent to which the students must devise a strategy for responding to the questions.

Provision of assessment materials and student work

Details of our requirements for the provision of assessment materials and student work for review are given in Appendix A and, in summary, include:

- the current specification
- all associated question papers
- final mark schemes
- reports from the examiners and grade boundaries (overall and by unit, and both raw and scaled)
- mark distributions, grade descriptions and assessment grids
- any other information that was routinely supplied to centres
- all the assessment work carried out by a sample of students whose final grade lay at or near the judgemental grade boundaries for the qualification being analysed.

The comparable materials that were collected and retained for the previous review were retrieved from our archive of assessment materials and student work.

Full details of the materials supplied by awarding organisations can be found in Appendix C and Appendix D.

The review team

We contracted 19 experts in GCE A level Chemistry to undertake the review. These reviewers were sourced through:

- a subject-expert recruitment exercise carried out by us in November 2010, advertised via the Times Educational Supplement and our website and newsletter
- nominations made by the regulators in Wales and Northern Ireland
- nominations made by awarding organisations involved in the review
- nominations made by subject associations and other learned organisations invited to participate in the review.

A full list of reviewers can be found in Appendix I.

We contracted a lead reviewer, specification reviewers and script reviewers. (All nominees from awarding organisations and subject associations were script reviewers.)

Analysis of the specifications and assessment materials

The lead reviewer and specification reviewers (specification review team) analysed the awarding organisations' materials using a series of forms, which can be found via the comparability page on our website at www.ofqual.gov.uk/research-and-statistics/research-reports/92-articles/23-comparability.

These analyses are designed to describe how demanding each specification is. Each reviewer analysed a subset of the specifications available, so that there were at least three different views on each specification. The lead reviewer then produced a report which brought together the views of the reviewers on each of the awarding organisations' specifications. The specification review team had the opportunity to discuss the lead reviewer's conclusions at a follow-up meeting. These findings are presented in Section 2 of this report.

Analysis of student performance

To assess student performance, all reviewers were brought together for a two-day meeting to analyse students' scripts (pieces of student work supplied by the awarding organisations). This process is referred to as a script review. The meeting started with a briefing session to ensure that all the reviewers had a common understanding of the methodology and the judgement criteria.

The scripts were organised into packs for consideration during the review. Packs were organised by grade. (Only grade boundaries A/B and E/U were analysed, as

grades B, C and D are calculated arithmetically after grade-boundary marks for grades A and E have been set during the awarding process carried out by the awarding organisations.)

As far as was possible, given the collection of scripts available, packs contained 12 scripts at the same grade, with at least one script from each awarding organisation from 2003 and 2008 (the remaining two scripts were selected at random).

Reviewers were then asked to rank the 12 scripts in each pack, from best to worst, on a data-entry sheet and to make comments on the scripts as necessary. Each reviewer completed a maximum of 14 sessions over the two-day review.

During the two-day meeting there were plenary sessions for reviewers to discuss the script review process and the quality of the scripts being analysed.

Data analysis

We use a software package called FACETS to analyse the results from data-entry sheets produced during the script review. FACETS uses a Rasch model (often classified under item response theory) to convert the qualitative ranking decisions made by reviewers into a single list that reflects the probable overall order of the sets of student work, from best to worst.

We use this list, alongside the qualitative comments made during the script review and the findings from the specification review, to inform Section 3 of this report.

Section 2: Subject demand in GCE A level Chemistry

Overview

Specification reviewers considered the amount and type of knowledge about chemistry required by each awarding organisation's specifications. They did this by analysing the specification documents, the reports from examiners and the question papers with associated mark schemes from each of the awarding organisations from 2003 and 2008. Details of the specifications included in the review are given in Appendix C.

Generally, the specifications became less demanding between 2003 and 2008. While the assessment objectives and specification content remained unchanged in the two years reviewed in this study, the question papers were not as demanding. Reviewers observed a more extensive use of short-answer questions and highly structured or "scaffolded" questions, to the detriment of the less-structured, free-response questions. In addition, in 2008 there were many more, less demanding questions similar in style and content to those in GCSE when compared with 2003.

Findings

Specification content

AQA

There was slightly less chemistry content in the specification in 2008 than in 2003. The topics removed were the chemistry of epoxyethane, the chemistry of beryllium and some specific reactions, such as the reduction of an aldehyde with $NaBH_4$.

At A2 the topics included Gibb's free-energy calculations and entropy, both of which are challenging and these were not seen on the other specifications reviewed. The inclusion of such topics made the content slightly more demanding. However, the inclusion of extraction of metals, with only a slight increase in content from that expected at GCSE level, was considered to counterbalance this. There was a good balance of content seen between the three disciplines of physical, organic and inorganic chemistry, and complete coverage of the topics expected in the criteria for GCE A level Chemistry.

CCEA

The content was deemed appropriate when compared with the requirements of the criteria; there was therefore the required balance between the three disciplines of physical, organic and inorganic chemistry. There were elements of the content present that build on GCSE work and some that give a good foundation for further study.

"Extra" topics included the hydrogen line spectrum, carbohydrates and identification tests. Material relating to nitriles replaced that relating to amides. Modern analytical methods included colorimetry as well as the expected topics from the criteria. The reviewers considered that the greater breadth of topics included in this specification had the potential to provide an excellent assessment instrument, but that this opportunity was lost in practice.

In both years reviewed, the A2 papers were less structured than at AS and set in appropriate A2 contexts with a demanding time allowance. But the question papers contained a high proportion of objective-test and short-answer (often one-mark), questions, giving limited testing of higher-order skills, which made them less demanding.

Edexcel

The specification content did not alter between 2003 and 2008. The content conforms to that expected from the criteria for GCE A level Chemistry and contains the requisite number of topics. But the order in which the topics are grouped together was different from that seen in the other awarding organisations' specifications. Reviewers considered that there was an different division of material for the organic chemistry between AS and A2, which excluded the study of organic reaction mechanisms until the A2 section of the course and that there was an over-reliance on traditional wet tests coupled with the requirement to recall a great many reagents and conditions.

Reviewers considered that a strength of the specification was that it explained the scheme of assessment very clearly. The guidance for teachers is very easy to follow, and useful summaries of topics are provided, for example table 2 page 7 (in the specification for 2008). There were comprehensive appendices, which supported teacher and learner.

OCR

For the core content the range of topics is similar to that the specifications of other awarding organisations, although somewhat reduced allowing for the contribution of the option material. There were no major changes to the specification between 2003 and 2008, except that one of the options was removed from the specification for the 2008 examination session. There are a large number of optional topics.

The optional topics are:

- Biochemistry, Unit 2815/02
- Environmental chemistry, Unit 2815/03

- Methods of analysis and detection, Unit 2815/04
- Gases, liquids and solids, Unit 2815/05 (offered only in 2003)
- Transition elements, Unit 2815/06.

Some of the optional topics were considered quite demanding. In order to ensure a similar level of demand in the optional topics, the weighting for each Assessment Objective is set to an agreed tolerance. As the assessment objectives allocated to the questions for the optional topics were not the same, students studying the same specification were not necessarily undertaking work that was equally demanding. The number of options available in this specification means that an individual student may experience less breadth of topics covered for the GCE A level qualification, but some material would be covered in more depth than in other specifications.

WJEC

The overall range of topics given in the specification covered the requirements of the criteria fully. However, the topic material is divided between AS and A2 differently from the way it is in other awarding organisations' specifications. For example, organic chemistry is covered more in A2.

There is a higher proportion of inorganic chemistry content at A2 here than in the specifications of other awarding organisations. This duplicates topics covered at GCSE level and those covered at AS. For example, Groups 2 and 7 from AS are revisited at A2 and Group 1 studied at GCSE is also included in the A2 material.

Schemes of assessment

In general, the AS and A2 each consisted of three assessed units: two theory and one practical. The third unit for each generally consisted of a written question paper and some form of assessment of the practical aspects of GCE A level Chemistry. Although for CCEA the third assessment unit addressed only the practical aspects of the course.

Although this assessment structure was common amongst the awarding organisations reviewed (as it is specified in the subject criteria), the nature of the assessment instrument chosen by each one was very different, and so there were no generalisations about this that could be made.

Question papers and mark schemes

Question papers were constructed in many different formats, with papers consisting of wholly multiple-choice questions (for example, AQA CHM6), a few multiple-choice questions with some structured questions (for example, CCEA CH1/2/4/5) or with a

combination of structured questions and those requiring more extended written answers (for example, WJEC CH5 and AQA CHM5).

Generally, the 2008 papers were less demanding than those of 2003. This was caused by three factors. Firstly, an over-reliance on short-answer questions in the question papers reviewed. There were few questions requiring students to formulate their answers in more extended continuous prose.

Second, there was an inappropriate amount of content judged to be at (or very close to) GCSE level in the papers taken in both 2003 and 2008. Some similarity is appropriate at AS, especially to provide accessibility to lower-attaining students. However the GCSE-level content provided a significant proportion of the total marks in many cases. For example, in one instance it was found that questions covering material at GCSE level provided 25 per cent of the total marks for the paper.

And finally, the use of scaffolding in questions was more prevalent in the 2008 papers than in those of 2003. Reviewers found extensive use of scaffolding in the longer questions given in section B of the question papers. Here the scaffolding was used to guide the free-response questions to such an extent that there was little opportunity for the students to construct an extended response in their answers. Both written and calculation questions were structured in this way.

Options within question papers

In general, awarding organisations did not offer any optional questions within their written examination papers. The exception to this was Edexcel, which offered a choice of two questions from the three available on the final paper, Unit 6B. Reviewers found that some of the optional questions were more highly structured than others – for example questions 3 and 4 compared with question 2 in 2008 – and that their mathematical content differed markedly – for example, question 2 contained a large proportion of mathematical content compared with no mathematics in questions 3 and 4, again from the 2008 paper. This could be expected, as each question covered one of the disciplines of organic, inorganic or physical chemistry, and each therefore reflected the different skill sets students required to attempt each question. However, for these reasons the questions could not be considered of comparable demand.

Accessibility to the full range of students

Question papers were considered for their accessibility for lower-attaining students and also for their provision of challenging questions for the most able. All the written examination papers reviewed began with less demanding questions or utilised the less demanding topics from the specification. There was some material included in the AS papers that was judged to be at, or very close to, GCSE standard and again

this should allow better accessibility to the less able students taking the qualifications.

However, at the other end of the scale, there were differences between awarding organisations in terms of how much the more able candidates could show what they were capable of through the questions.

So, for example, in each of CCEA Papers 1, 2, 4 and 5 there was only one question requiring extended writing and on each occasion students received specific direction about the material they should include in their answers. This lowered the complexity of the question and so too the student's response to it, meaning that students did not need to show much independent strategy in the formulation of their response.

Edexcel papers had fewer opportunities for high-achieving students to demonstrate their knowledge and skill when compared with papers in 2003. In 2003 the latter parts of almost all questions provided ample opportunity for high-achieving students to score marks to set them above the rest, but this was not carried forward into 2008.

Practical examinations and coursework

Awarding organisations use a combination of practical examinations and coursework to examine students' skills. A large difference in the weighting of this practical component was seen across the awarding organisations and these weightings are summarised in Appendix K. This variation was permitted by the subject criteria. Formal practical examinations, where offered (AQA, Edexcel and OCR for both AS and A2, CCEA at AS only), differed significantly by duration. For example, OCR had the shortest examination at 1 hour 30 minutes, and CCEA the longest with its 2 hour 30 minutes practical examination at AS. WJEC was alone in only assessing practical work by internally marked, externally moderated coursework.

The contribution of a practical component to the overall GCE A level varies for each awarding organisation reviewed, ranging from 5 to 10 per cent. This is within the range permitted by the subject criteria, but reviewers believed weighting at the lower end of this range to be insufficient for a subject like chemistry at this level.

For CCEA, reviewers judged that the method of assessment for module 6B had limitations. Within the teacher-assessed coursework, each of the four skills was assessed by giving a mark of 0, 1 or 2 per skill, greatly limiting the amount of discrimination between different levels of performance possible between students.

The practical examinations offered by Edexcel in 2008 improved on those offered in 2003. In 2003 the alternative routes for assessment of the practical component were not comparably demanding whereas in 2008 such differences had been evened out.

WJEC offers optional assessment methods. The practical aspect can be assessed by internally marked and externally moderated coursework (option CH3 A and C) or by

coursework that is both externally set and marked (option CH3 A and B). Whilst it may appear that WJEC allocates only 5 per cent of the total weighting for the GCE A level to the practical component – the same as AQA, which reviewers considered insufficient – practical aspects of the course are also assessed in the question papers CH3a and CH6a, which each contributes 10 per cent to the total.

Section 3: Standards of performance

Overview

Process

Reviewers considered students' work from all of the awarding organisations in 2003 and 2008. Details of the materials used are provided Appendix D,

Interpreting the graphs

The graphs below show the spread of the student work, as produced by the FACETS software. The dots indicate the measure related to the relevant ranked script and the error bar "whiskers" represent the standard error of measurement (SEM) to the corresponding measure. The difference between sequential measures demonstrates the strength of the difference in the ranking position. Therefore, large differences illustrate that scripts were less close in terms of similarity of student performance than small differences. Therefore, there could be a larger difference in judged student performance between scripts ranked 1 and 2 than between those ranked 2 and 3 (the difference in student performance is not necessarily the same between ranked positions).

The SEM illustrates the level of confidence that the measure is accurate: the greater the SEM, the smaller the confidence levels. Therefore, large whiskers mean that there is less confidence that the measure was accurate. The whiskers illustrate the level of confidence, showing upper and lower points at which the measure could lie.

The FACETS software will usually produce a rank order, even when there is little difference in the quality of the student work considered in the review. This is due to the natural slight variability between students who get the same mark. In these cases the rank order would show a relatively even spread of student work from different awarding organisations throughout the rank order.

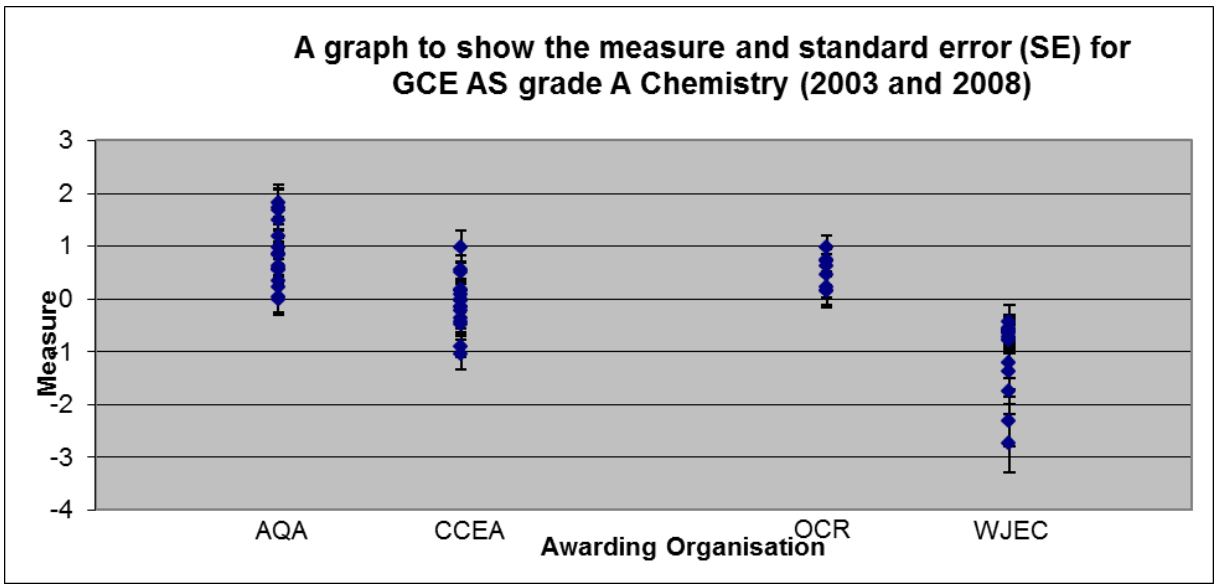
The scripts have been separated by awarding organisation for ease of reference, represented in alphabetical order across the horizontal axis (but can be found as a continuous inter-awarding organisation list in table format in Appendix H).

Findings

We were unable to analyse Edexcel's scripts as we could not locate the full sample in Ofqual's archive.

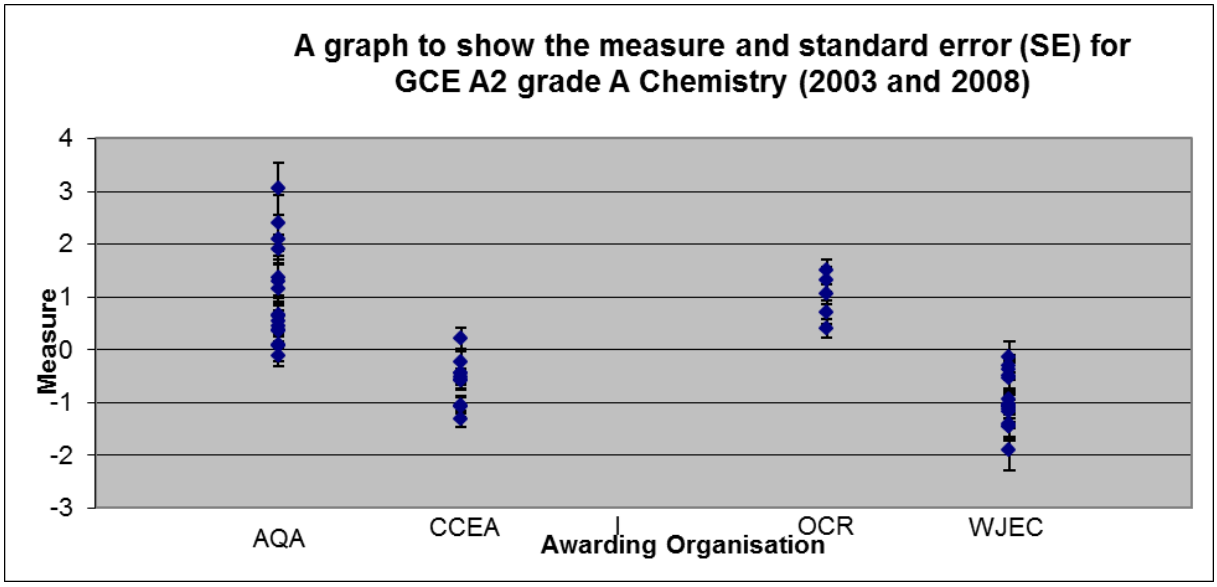
Performance at the GCE AS grade-A boundary (2003 and 2008)

In both years a similar spread of ranking positions was observed, with the majority of AQA scripts appearing towards the top, OCR and CCEA scripts predominating in the inter-quartile range (the middle two quartiles) and WJEC's scripts appearing towards the bottom of the rankings.



Performance at the GCE A2 grade-A boundary (2003 and 2008)

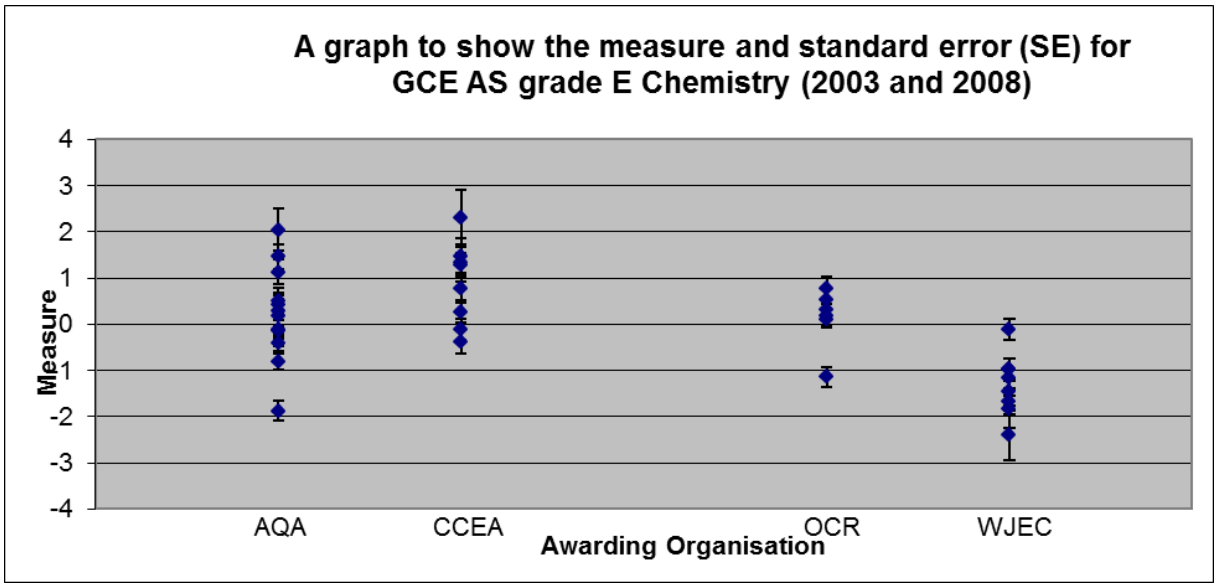
Overall, AQA and OCR's student work was ranked higher in the order than that of CCEA and WJEC.



Performance at the GCE AS grade-E boundary (2003 and 2008)

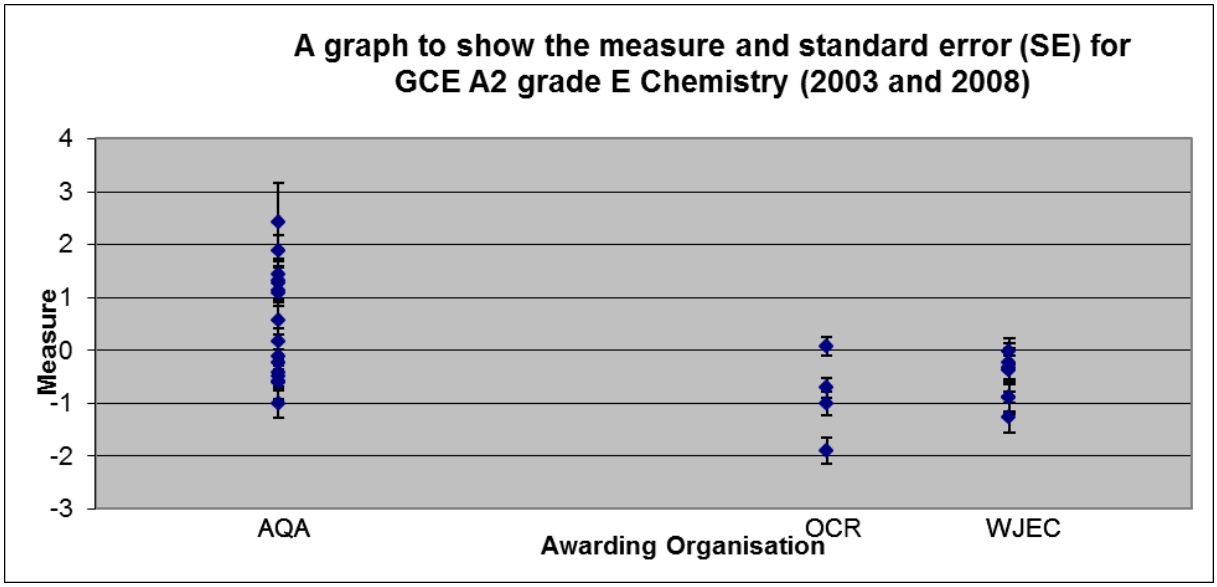
The number of scripts reviewed for each awarding organisation was highly variable, so drawing conclusions from the results was more difficult than if there had been an equal number of scripts reviewed for each awarding organisation.

In terms of the percentage distribution of scripts, AQA and CCEA were ranked higher than OCR and WJEC.



Performance at the GCE A2 grade-E boundary (2003 and 2008)

The analysis at this grade boundary and level was limited by the number of scripts available. The results should be interpreted with greater caution than if a full complement of scripts had been available from each awarding organisation for the two years reviewed.



Conclusions

We are talking to higher education institutions, amongst others, about the content and demand of A levels in the future, so that they meet the needs and expectations of people who will use them in the future. How this qualification has changed over time, and the impact that this change has had on perceptions of demand and preparation for higher education, will inform the next generation of qualification and subject criteria.

Specifically, we recommend that explicit consideration is given to how much overlap, if any, between the content of GCSE qualifications and AS assessments is acceptable, in terms of both accessibility to less able students and the amount of progression from GCSE that should be expected before AS assessments take place.

Additionally, consideration should be given to the following.

- Whether there are changes that could be made to subject criteria restricting question types in papers to avoid the reduction in demand
- Whether there should be tighter requirements on the amount of practical assessment undertaken as part of the qualification.

Appendix A: Provision of assessment materials and student work at GCSE and GCE levels for Ofqual's archive (annual inclusion and standards reviews)

Section 1: Specification of requirements

1.1 Each awarding organisation should draw the materials for each subject from the specification with their largest entry in summer 2009, unless that selection severely limits the range of examination components available. Where there are several entry options, materials should be drawn from the largest option only, unless Ofqual were exceptionally to agree other arrangements.

1.2 (With regards to GCSE) – where there are both modular and linear (non-modular) examinations in a subject, the awarding organisation operating the modular scheme with the greatest number of students (amongst all awarding organisations) should include that modular scheme, even if it is not a specification within the awarding organisation's largest entry. Similarly, the awarding organisation operating the linear scheme with the greatest number of students should include that linear scheme. If an awarding organisation runs both the largest entry linear examination and the largest entry modular examination in a subject, it will therefore provide two sets of materials, including student work, where required.

1.3 The following materials should be supplied:

a) Current specification: all associated question papers and final mark schemes.

b) The reports from examiners and details of procedures particular to the specification supplied.

c) An indication of how the specification's content and assessment criteria and objectives have been met in each question paper supplied. This may take the form of a grid. For objective tests this should include faculty values, discrimination indices and a specification grid detailing what grade each question was targeted at, as well as an indication of what percentage of students got a particular question correct when it was targeted at the grade they got overall.

d) Unit or component mark distributions (with grade boundary marks shown). It should be clear whether the marks are on the raw or uniform mark scale.

e) Grade boundaries, overall and by unit (both raw and scaled).

f) Student work as specified in Section 2.

g) Complete data record showing for each student selected the raw mark; final mark; weighted or uniform mark; grade for each component/unit (including any non-archived component/unit) and overall grade; and, where relevant, tier of entry.

Where appropriate, materials a)–e) may be supplied in electronic form.

Section 2: Student work

2.1 The work submitted should include the examination scripts, the internal assessment, and any oral/ aural examinations (with examiner mark sheet) where these are routinely recorded. In addition, for modular specifications, the examination papers of module tests should be supplied.

2.2 The sample should be of the original work of the students. Photocopies of work should only be used where it is impossible to send the originals and with agreement in advance by Ofqual. Student and centre names and numbers should be removed wherever they appear in a student's work, unless they form an integral part of the work, for example, within a letter.

2.3 Where an awarding organisation's specification has a relatively small entry or where, for some other reason, it is proving difficult to find sufficient students who fulfil the criteria, the awarding organisation should contact the Ofqual officer responsible to agree how best to finalise the sample.

2.4 All internal assessment submitted should be that of the particular students selected for the sample. If, for any reason, this proves to be impossible, the awarding organisation should contact the Ofqual officer responsible to agree appropriate alternative measures.

2.5 The sample of scripts retained for each specification (option) should be taken from students whose final mark lay at or near the subject grade boundaries for A/B, C/D and F/G for GCSE and A/B and E/U for GCE A-level qualifications. At each boundary, each awarding organisation will supply the externally and internally set and marked assessments of fifteen students. Students selected should be those whose performance across units is not obviously and significantly unbalanced.

2.6 In tiered subjects, where the same grade boundary may feature in two tiers, separate sets of student work for the boundary should be provided from each tier.

In addition for AS/A level specifications:

2.7 Where awarding organisations have to supply student work for an A level specification, two samples are required: one for the AS and one for the A2 units.

2.8 For AS level, the work of 15 students whose mark for the AS is at or close to the UMS boundary for an AS grade A (240) or grade E (120) should be supplied.

Students selected should be those whose performance across the three AS units is not obviously or significantly unbalanced. Students should have taken at least two of the three AS units in the June examination series.

2.9 For A level, the sample comprises the A2 work of 15 students who have gained c240 UMS marks at A or c120 UMS marks at E on their A2 units. Students selected should be those whose performance across the three A2 units is not obviously or significantly unbalanced. Students selected will ideally have also gained an overall A level mark which is at or close to the UMS boundary for an overall A level grade A (480) or grade E (240). Students should have taken at least two of the three A2 units in the June examination series.

2.10 The set of AS and A2 units provided should also be a valid combination for A level.

2.11 Where coursework forms a compulsory sub-component within a unit, that coursework should also be collected. Where a unit has optional sub-components, the highest entry option should be supplied. The students chosen for the sample should, as far as possible, have a performance across the components of the unit which is not obviously unbalanced.

Appendix B: Schemes of assessment

AQA

Paper	Time allowed (mins)	Total marks	Time per mark (mins)	Type of assessment	Type of questions	Contribution (%)
CHM1	60	60	1	Written exam	Structured questions in section A and more extended answer questions in section B	15
CHM2	60	60	1	Written exam	Structured questions in section A and more extended answer questions in section B	15
CHM3a					Structured questions in section A and more extended answer questions in section B	12.5
CHM3b		30		Practical exam or internally assessed coursework	120 minutes	7.5
CHM4	90	90	1	Written exam	Structured questions in section A and more extended answer questions in section B	15

CHM5	120	120	1	Written exam	Structured questions in section A and more extended answer questions in section B	20
CHM6a	60	60	1		Multiple-choice questions	10
CHM6b		30		Practical exam or internally assessed coursework	120 minutes	5

CCEA

Paper	Time allowed (mins)	Total marks	Time per mark (mins)	Type of assessment	Type of question	Contribution (%)
AS 1	90	100	0.9	Written exam	Ten multiple-choice questions in section A and structured questions in section B	17.5
AS 2	90	100	0.9	Written exam	Ten multiple-choice questions in section A and structured questions in section B	17.5
AS 3	90	150	1.7	Practical exam	Two practical exercises, as well as two written ones.	15
A2 1	90	90	1	Written exam	Ten multiple-choice questions in section A and structured questions in section	15

					B	
A2 2	90	90	1	Written exam	Ten multiple-choice questions in section A and structured questions in section B	15
A2 3A	90	80	0.89	Synoptic paper	Structured questions and a planning exercise	13.3
A2 3B	N/A	40	N/A	Internally assessed coursework		6.7

Edexcel

Paper	Time allowed (mins)	Total marks	Time per mark (mins)	Type of assessment	Type of question	Contribution (%)
1	60	60	1	Written exam	Structured questions only	15
2	60	60	1	Written exam	Structured questions only	15
3A	50	105		Practical exam or internally assessed coursework		10
3B	50	60	0.9	Written exam	Structured questions only	10
4	90	75	0.9	Written exam	Structured questions only	15
5	90	75	0.9	Written exam	Structured questions only	15
6A	50	105	1	Practical exam		10

				or internally assessed coursework		
6B	90	50	0.55	Written examination (synoptic paper)	Section A contains structured questions and Section B contains three questions from which students choose to answer two.	10

OCR

Unit/ component title	Time allowed (mins)	Total marks	Type of assessment	Type of question	Contribution (%)
2811	60	60	Written exam	Structured questions and those requiring more extended answers	15
2812	60	60	Written exam	Structured questions and those requiring more extended answers	15
2813 - /01 /02 /03	 45 N/A 90	45	 Written exam Coursework Written exam	Structured questions and those requiring more extended answers	 10 10 10
2814	90	90	Written exam	Structured questions and those requiring	15

				more extended answers	
2815 – /01 and /02 **Or** /03 or /04 or /05 or /06	60 and 50 50 50 50 50	45 and 45 for the option taken This option not available in 2008	Written exam Written exam Written exam Written exam Written exam	Structured questions and those requiring more extended answers for core and option question papers	Core= 7.5 and 7.5 7.5 7.5 7.5
2816 /01 /02 /03	75 90		Written exam Coursework Formal practical exam	Structured questions and those requiring more extended answers. Structured questions and those requiring more extended answers	10 10 10

WJEC

Paper	Time allowed (mins)	Total marks	Time per mark (mins)	Type of assessment	Type of question	Contribution (%)
CH1	90	66	1.36	Written exam	Structured questions and objective questions	17.5
CH2	90	66	1.36	Written exam	Structured questions and objective questions	17.5
CH3a	45	30	1.5	Written exam "Theory and experiment interface"		5
CH3b/c		103		Internally assessed coursework		10
CH4	100	75	1.33	Written exam	Two or three structured questions + two free response questions	15
CH5	100	75	1.33	Written exam	Two or three structured questions + two free response questions	15
CH6a	70	50	1.4	Written exam	Synoptic paper – one question for ten marks + one comprehension + two structured questions	10
CH6b/c		30		Internally assessed coursework		10

Appendix C: GCE A level specifications reviewed

		Awarding organisation and specification codes				
		AQA	CCEA	Edexcel	OCR	WJEC
Year	2003	5421	S1110	8080	3882	006090
		6421	A1110	9080	7882	033080
	2008	5421	S1110	8080	3882	006090
		6421	A1110	9080	7882	033080

Appendix D: GCE A level scripts reviewed

		Awarding organisation									
		AQA		CCEA		Edexcel		OCR		WJEC	
	Year / Grade	2003	2008	2003	2008	2003	2008	2003	2008	2003	2008
AS	A	*15	*15	*16	*14	*0	*9	*14	*15	*15	*15
	A	**8	**8	**8	**8	**0	**8	**8	**0	**8	**8
	E	*15	*15	*0	*15	*0	*15	*7	*14	*0	*15
	E	**4	**8	**0	**8	**0	**8	**6	**0	**0	**8
A2	A	*15	*15	*10	*7	*0	*12	*10	*15	*15	*15
	A	**8	**8	**4	**6	**0	**8	**5	**0	**8	**8
	E	*15	*15	*1	*0	*0	*11	*5	*0	*0	*15
	E	**8	**8	**0	**0	**0	**8	**5	**0	**0	**8

* Number of student scripts (student work) received from the awarding organisation

** Number of student scripts used in the script review

Appendix E: Availability of specification materials for the purposes of this review

Materials	2003					2008				
	AQA	**CCEA**	**Edexcel**	**OCR**	**WJEC**	**AQA**	**CCEA**	**Edexcel**	**OCR**	**WJEC**
Specification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Question paper	✓	✓	✓	✓	✓	✓	✓	✓	✖	✓
Mark scheme	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reports from examiners	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mark distribution	✓	✖	✓	✓	✓	✓	✖	✓	✓	✓
Grade boundaries	✓	✓	✓	✓	✓	✓	✓	✓	✖	✓
Assessment grids	✖	✓	✓	✖	✓	✓	✓	✖	✓	✓

✓ Material was available and was used in the review

× Material was not available and was not used in the review

Appendix F: Student achievement by grade

Cumulative of grades awarded by awarding organisation for GCE A level Chemistry, 2003 and 2008

Awarding organisation and year	A	B	C	D	E	U	Total student entries
AQA 2003	31.71%	54.19%	72.65%	86.01%	95.44%	100.00%	10342
AQA 2008	34.73%	59.63%	77.82%	90.43%	97.35%	100.00%	11965
CCEA 2003	42.04%	61.43%	76.57%	87.56%	95.96%	100.00%	892
CCEA 2008	48.47%	68.68%	82.77%	90.83%	96.52%	100.00%	1178
Edexcel 2003	31.15%	54.87%	71.83%	85.19%	94.55%	100.00%	6224
Edexcel 2008	36.00%	57.44%	73.49%	85.39%	93.33%	100.00%	10621
OCR 2003	28.03%	54.25%	73.39%	87.12%	95.84%	100.00%	7757
OCR 2008	31.27%	57.10%	75.58%	88.19%	96.10%	100.00%	11284
WJEC 2003	31.02%	55.25%	75.12%	88.53%	97.25%	100.00%	1238
WJEC 2008	34.65%	59.01%	77.18%	89.65%	97.61%	100.00%	1420

Appendix G: Number of data pairs statistically analysed in the script review

Number of data pairs analysed			Number of blank lines	Number of missing/null observations	Number of valid responses used
Grade	A AS	5042	0	0	5042
	A A2	5360	0	0	5360
	E AS	3030	0	0	3030
	E A2	2150	0	0	2150

Appendix H: Measure, standard error and infit values of the ranked scripts

The “measure” value represents quality of student performance as judged by the reviewers. This is an estimate of where each script would be ranked if they were all put in order from highest to lowest in terms of performance in a single list. Positive values represent the scripts in the top half of all those reviewed.

The SE is the standard error of the estimated measure value. This is likely to be an underestimate as the analysis changed the rankings (as completed by reviewers on the date entry sheet for each session) into paired comparisons. The example table below illustrates this. There are four ranking positions. Each rank will be compared against every other position and not just in the order in which they appear.

Reviewer: number 1	
Ranking position	Script number
1	65
2	23
3	48
4	52

Paired comparisons made					
65,23	23,65				
65,48	48,65	23,48	48,23		
65,52	52,65	23,52	52,23	48,52	52,48

Each of the ranked scripts will be paired with each of the other ranked scripts twice for comparison. So, for example, rank 1 will be compared with rank 2 and rank 2 will be compared with rank 1 (hence the paired comparison).

The Infit Z value provides an indication of fit. The higher values indicate that there is more disagreement about the ranking of scripts, for example scripts that were sometimes ranked above good scripts but at other times ranked below poor scripts (therefore, not consistently positioned within the rankings).

The separation reliability value (infit mean squared) provided is an estimate of the proportion of variance in the script measures attributable to “true” variance as opposed to “error” variance. This is likely to be overestimated, as the as the analysis changed the rankings into paired comparisons. The separation value, therefore, is how spread the group of measures of the scripts are. The higher the separation value the better, as this indicates more confidence in the degree of separation between the

scripts (that is to say that there is more certainty in the discrimination between them, as observed by the reviewers during the ranking exercise). Therefore, the order of the scripts (in terms of the quality of student performance) is more reliable for the sample of scripts reviewed. Note that the infit mean squared columns information will always be a positive number (as it has been squared).

The scripts are listed by student performance, with the highest first.

Chemistry: GCE grade A at AS

Measure	SE	Awarding organisation	Infit Mean Squared	Infit Zstd
1.82	0.27	AQA	1	0
1.74	0.43	AQA	1.02	0.1
1.69	0.39	AQA	0.96	0
1.5	0.34	AQA	1.06	0.3
1.19	0.22	AQA	1	0
0.99	0.3	CCEA	0.92	-0.6
0.98	0.22	AQA	1.06	0.6
0.97	0.24	OCR	0.87	-1.2
0.87	0.21	AQA	0.98	-0.2
0.84	0.2	AQA	1.03	0.3
0.74	0.21	OCR	0.93	-0.8
0.72	0.3	OCR	1.03	0.2
0.63	0.21	OCR	1.05	0.6
0.62	0.2	AQA	1.06	0.8
0.58	0.35	AQA	1.26	1.6
0.55	0.2	AQA	1.06	0.8

Chemistry: GCE grade A at A2

Measure	SE	Awarding organisation	Infit Mean Squared	Infit Zstd
3.05	0.49	AQA	1.01	0.1
2.41	0.53	AQA	0.94	0
2.09	0.3	AQA	1	0
1.9	0.27	AQA	0.78	-1.3
1.52	0.2	OCR	1.15	1.2
1.37	0.34	AQA	1.09	0.4
1.33	0.24	OCR	0.83	-1.2
1.3	0.32	AQA	1.19	1
1.15	0.23	AQA	1.04	0.3
1.06	0.19	OCR	1.08	0.8
0.71	0.22	OCR	0.92	-0.6
0.66	0.22	AQA	1.04	0.4
0.63	0.21	AQA	1.1	1
0.55	0.3	AQA	0.92	-0.4
0.46	0.29	AQA	0.89	-0.8
0.4	0.18	OCR	1.07	0.8

0.55	0.2	AQA	0.87	-1.5
0.55	0.27	CCEA	1.21	2.2
0.52	0.2	CCEA	0.91	-1.3
0.46	0.19	OCR	1.01	0.1
0.34	0.29	AQA	1	0
0.23	0.21	AQA	1.05	0.6
0.23	0.2	OCR	0.91	-1.2
0.18	0.34	CCEA	0.83	-1.1
0.16	0.32	OCR	0.85	-1.3
0.16	0.28	OCR	0.92	-0.6
0.16	0.2	CCEA	1	0
0.09	0.29	CCEA	0.98	-0.2
0.03	0.28	AQA	0.9	-0.8
-0.01	0.28	AQA	0.96	-0.4
-0.01	0.37	CCEA	1.45	2.3
-0.02	0.2	CCEA	1.13	1.9
-0.15	0.21	CCEA	0.98	-0.1
-0.15	0.2	CCEA	1.04	0.6
-0.23	0.27	CCEA	0.89	-1.4
-0.36	0.2	CCEA	1.05	0.8
-0.42	0.22	CCEA	1.05	0.6
-0.42	0.3	WJEC	0.99	0
-0.47	0.21	CCEA	1	0
-0.55	0.21	WJEC	0.95	-0.5

0.38	0.21	AQA	0.94	-0.5
0.35	0.3	AQA	0.99	0
0.22	0.2	CCEA	1.12	1.2
0.1	0.2	AQA	0.89	-1.2
0.08	0.29	AQA	0.91	-0.7
-0.11	0.2	AQA	1.06	0.7
-0.13	0.29	WJEC	0.91	-0.8
-0.24	0.21	CCEA	0.95	-0.5
-0.3	0.21	WJEC	0.93	-0.7
-0.36	0.2	WJEC	1.02	0.2
-0.44	0.21	CCEA	1.07	0.8
-0.45	0.21	CCEA	0.99	0
-0.48	0.29	WJEC	0.92	-0.5
-0.51	0.16	CCEA	0.97	-0.4
-0.53	0.29	WJEC	0.8	-1.5
-0.55	0.2	CCEA	1.02	0.2
-0.57	0.16	CCEA	1.03	0.5
-0.94	0.21	WJEC	0.98	-0.2
-1.02	0.21	WJEC	0.9	-1.2
-1.04	0.17	CCEA	1.03	0.4
-1.05	0.32	WJEC	0.95	-0.3
-1.07	0.3	WJEC	0.85	-1.2
-1.08	0.19	CCEA	1.11	1.2
-1.08	0.22	WJEC	0.99	0

-0.58	0.2	WJEC	1	0
-0.6	0.21	WJEC	0.95	-0.5
-0.6	0.31	WJEC	1.02	0.1
-0.62	0.21	WJEC	1.07	0.7
-0.63	0.3	WJEC	1.03	0.2
-0.65	0.21	WJEC	1.04	0.4
-0.71	0.21	WJEC	0.93	-0.7
-0.77	0.21	WJEC	0.87	-1.4
-0.79	0.2	WJEC	0.98	-0.2
-0.9	0.19	CCEA	1.09	1.1
-1.05	0.29	CCEA	1.06	0.5
-1.21	0.29	WJEC	1.01	0.1
-1.38	0.34	WJEC	1.05	0.3
-1.74	0.25	WJEC	0.99	0
-2.32	0.46	WJEC	0.92	-0.1
-2.73	0.56	WJEC	1	0.1

-1.12	0.33	WJEC	0.98	0
-1.16	0.21	WJEC	1.08	0.8
-1.31	0.16	CCEA	1.04	0.5
-1.4	0.31	WJEC	1.01	0.1
-1.44	0.22	WJEC	0.97	-0.2
-1.44	0.23	WJEC	1.01	0.1
-1.89	0.4	WJEC	0.93	-0.1

Chemistry: GCE grade E at AS level				
Measure	SE	Awarding organisation	Infit mean squared	Infit Zstd
2.3	0.61	CCEA	1.04	0.2
2.05	0.46	AQA	0.88	-0.3
1.48	0.39	CCEA	1.02	0.1
1.47	0.27	AQA	1.02	0.1
1.33	0.4	CCEA	0.98	0
1.28	0.26	CCEA	1.19	1.3
1.14	0.27	AQA	0.99	0
0.79	0.33	CCEA	0.72	-2.2
0.78	0.26	OCR	1.01	0.1
0.54	0.23	OCR	1.02	0.2
0.52	0.26	AQA	0.97	-0.2
0.43	0.25	AQA	1.02	0.1
0.31	0.2	OCR	0.98	-0.2
0.29	0.33	AQA	0.83	-1.5
0.28	0.24	CCEA	1.07	0.7
0.2	0.23	OCR	1.01	0.1
0.18	0.37	AQA	0.9	-0.5
0.12	0.2	OCR	1.01	0.1
-0.1	0.23	CCEA	0.83	-1.9
-0.1	0.2	AQA	1.02	0.2

Chemistry: GCE grade E at A2 level				
Measure	SE	Awarding organisation	Infit mean squared	Infit Zstd
2.43	0.74	AQA	0.97	0.1
1.88	0.29	AQA	1.04	0.2
1.43	0.48	AQA	0.98	0
1.32	0.42	AQA	1.01	0.1
1.27	0.31	AQA	1.03	0.2
1.14	0.31	AQA	0.98	0
1.09	0.25	AQA	0.82	-1.1
0.58	0.27	AQA	1.09	0.8
0.17	0.25	AQA	1.04	0.4
0.08	0.18	OCR	1.03	0.5
-0.02	0.25	WJEC	1.14	1.3
-0.1	0.26	AQA	0.88	-1.1
-0.22	0.36	WJEC	1.01	0
-0.24	0.25	AQA	0.98	-0.1
-0.33	0.24	WJEC	1.01	0.1
-0.37	0.42	WJEC	0.84	-0.9
-0.37	0.26	WJEC	1.12	1.3
-0.41	0.27	AQA	1.18	1.3
-0.49	0.26	AQA	0.95	-0.4
-0.57	0.41	AQA	0.72	-1.7

-0.1	0.23	WJEC	1	0
-0.14	0.33	AQA	1.07	0.5
-0.38	0.25	CCEA	1.13	1.1
-0.41	0.16	AQA	1.03	0.4
-0.8	0.18	AQA	0.92	-1
-0.98	0.25	WJEC	1.02	0.2
-0.98	0.25	WJEC	0.94	-0.5
-1.14	0.21	OCR	0.96	-0.3
-1.15	0.4	WJEC	0.97	0
-1.46	0.29	WJEC	1.08	0.5
-1.66	0.28	WJEC	1.07	0.5
-1.83	0.41	WJEC	0.92	-0.2
-1.87	0.21	AQA	1.03	0.3
-2.4	0.53	WJEC	0.95	0

-0.61	0.32	AQA	0.99	-0.1
-0.71	0.18	OCR	1.08	1.1
-0.88	0.27	WJEC	0.89	-0.9
-0.88	0.33	WJEC	0.99	0
-1.01	0.22	OCR	0.99	-0.1
-1.01	0.27	AQA	0.92	-0.6
-1.27	0.28	WJEC	0.96	-0.2
-1.9	0.24	OCR	1.01	0.1

Appendix I: Review team

Review team		Organisation
Lead reviewer	Yvonne Walls	Ofqual reviewer
Specification reviewers	Suzanne Bzikot	Ofqual reviewer
	Philip Eastwood	Ofqual reviewer
	Stephen Plant	Ofqual reviewer
	Susan Walker	Ofqual reviewer
Script reviewers	Sunetra Berry	Ofqual reviewer
	Alan Clamp	Ofqual reviewer
	Veronica Mitchell	Ofqual reviewer
	Siegfried Nolze	Ofqual reviewer
	John Payne	Ofqual reviewer
	Simon Rees	Ofqual reviewer
	Geraldine Newlyn	AQA
	Dr Barrie Crowther	CCEA (awarding organisation)
	John Apsey	Edexcel
	Phil Hills	OCR
	David Ballard	WJEC
	Nick O'Brien	Association for Science Education
	Robert Maguire	CCEA (Regulator)
	Stuart Jones	The Welsh Government (previously DfES)

Appendix J: Assessment objectives

The assessment objectives will assess a student's ability in the following areas.

AO1 Knowledge with understanding

Students should be able to:

(a) recognise, recall and show understanding of specific chemical facts, terminology, principles, concepts and practical techniques;

(b) draw on existing knowledge to show understanding of the responsible use of chemistry in society;

(c) select, organise and present relevant information clearly and logically, using specialist vocabulary where appropriate.

AO2 Application of knowledge and understanding, analysis and evaluation

Students should be able to:

(a) describe, explain and interpret phenomena and effects in terms of chemical principles and concepts, presenting arguments and ideas clearly and logically, using specialist vocabulary where appropriate;

(b) interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams and graphs;

(c) carry out relevant calculations;

(d) apply chemical principles and concepts to unfamiliar situations, including those related to the responsible use of chemistry in society;

(e) assess the validity of chemical information, experiments, inferences and statements.

AO3 Experiment and investigation

Students should be able to:

(a) devise and plan experimental and investigative activities, selecting appropriate techniques;

(b) demonstrate safe and skilful practical techniques;

(c) make observations and measurements with appropriate precision and record these methodically;

(d) interpret, explain, evaluate and communicate the results of their experimental and investigative activities clearly and logically using chemical knowledge and understanding, and using appropriate specialist vocabulary.

Assessment objective 4 applies only to the A2 part of the A level course.

AO4 Synthesis of knowledge, understanding and skills

Students should be able to:

(a) bring together knowledge, principles and concepts from different areas of chemistry, including experiment and investigation, and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary;

(b) use chemical skills in contexts which bring together different areas of the subject.

Appendix K: Coursework summary

	AS			A2		
Awarding organisation	Practical component	Assessment type	Weighting (%)	Practical component	Assessment type	Weighting (%)
AQA	CHM3C	Internally assessed coursework	7.5	CHM6C	Internally assessed coursework	5
	CHM3P	Externally assessed practical exam 2 hours	7.5	CHM6P	Externally assessed practical exam 2 hours	5
CCEA	AS 3	Externally assessed practical exam 2 hours 30 minutes	15	A2 3	Internally assessed coursework	6.7
Edexcel	Unit 3A	Internally assessed coursework or Externally assessed practical exam 1 hour 45 minutes	10	Unit 6A	Internally assessed coursework or Externally assessed practical exam 1 hour 45 minutes	10

OCR	Unit 2813/02	Internally assessed coursework	10	Unit 2816/02	Internally assessed coursework	10
	Unit 2813/03	Externally assessed practical exam 1 hour 30 minutes	10	Unit 2816/03	Externally assessed practical exam 1 hour 30 minutes	10
WJEC	CH3b	Internally assessed coursework	10	CH6b	Internally assessed coursework	5
	CH3c	Externally assessed coursework	10	CH6c	Externally assessed coursework	5

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