Review of standards in GCE mathematics in 2004 and 2007

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Introduction

As the regulator of external qualifications in England, Ofqual is responsible for ensuring the maintenance of GCE and GCSE standards over time and across awarding bodies. One of the ways it does this is through a programme of standards reviews. These reviews investigate examination standards and determine whether any action is needed to safeguard them. They are carried out periodically, covering the major subjects at both GCSE and A level. To keep the work manageable, the reviews consider only the highest entry syllabus from each awarding body. This report is about the review of standards in GCE mathematics in 2004 and 2007.

In 2005 the Qualifications and Curriculum Authority (QCA) published a report on standards over time in A level mathematics, comparing A level mathematics examinations in 1998 and 2004. The report is available on the Ofqual website (www.ofqual.gov.uk). The key issues identified by the enquiry were considered as part of this review.

It should be noted that a rolling programme of subject reviews on a five-year cycle came about as a direct response to one of the key recommendations contained with in Lord Dearing's 1996 review of qualifications for 16- to 19-year-olds. The programme of reviews also followed on from an investigation of standards in a restricted number of subjects (including mathematics) by Schools Curriculum and Assessment Authority (SCAA)[1] and the Office for Standards in Education, published in *Standards in public examinations 1975–1995* (1996).

Between them, the A level syllabuses included in this review attracted 74 per cent of the 67,000 candidates who took A level mathematics in 2007.

This report provides details about standards in A level mathematics examinations across the awarding bodies Assessment and Qualifications Alliance (AQA), Northern Ireland Council for Curriculum Examinations and Assessment (CCEA), Edexcel, Oxford, Cambridge and RSA Examinations (OCR) and WJEC (previously the Welsh Joint Education Committee).

[1]The merger in 1997 between SCAA and National Council for Vocational Qualifications (NCVQ) created QCA. Legislation currently going through Parliament will split QCA to create Ofqual and Qualifications, Curriculum and Development Authority (QCDA). In the meantime, Ofqual operates as part of QCA.

Examination demand in A level mathematics

The major issue that affected A level mathematics examinations between 2004 and 2007 was the introduction of revised syllabuses across all awarding bodies for teaching from September 2004. The balance between pure mathematics and applied mathematics was changed. In 2004 three of the six units comprising A level were pure mathematics and three were applied mathematics. AS mathematics comprised 3 units, P1, P2 nad an applications unit. The AQA specification varied from this model in that it offered a mathematical methods unit (Me), which covered most of what was in P1 (for most awarding bodies) with some content from statistics. Their P1 comprised the remainder of other awarding bodies' P1 content together with the AS content from P2, creating a second unit at AS standard. The AQA AS mathematics thus comprised Me, P1 and an AS applications unit.

By 2007 the design of both the AS and A level had changed, although the number of units remained at six, and all awarding bodies produced syllabuses of similar design. The major innovation was the introduction of four core units of pure mathematics, two of which were AS and two of which were A2. The content of the three pure units in 2004 was subdivided into four and spread across the four new core units. The content of pure for AS and A2 was consistent across all awarding bodies. In addition, the first core unit, C1, was deliberately designed to allow better access for students from GCSE and was designated a non-calculator paper. This change was in direct response to criticisms made regarding the accessibility of AS from GCSE in the syllabuses introduced for first teaching in 2001.

The remaining two units could be chosen from a range of applied units covering mechanics, decision mathematics and statistics. Both of the units could be of AS standard, thus allowing the possibility of studying an A level comprising four AS units and two A2 units.

The main requirement of the changes was to carry forward the full A level standard.

To summarise, the most significant changes for A level mathematics between 2004 and 2007 were (with the exception of the AQA model described above):

- the introduction of four units, C1–C4, which cover the core of pure mathematics previously covered by three units P1–P3
- a reduction (from three to two) in the number of applications units studied
- the introduction of a non-calculator paper to replace one or more 'scientific calculator only' papers.

Key issues identified in previous review of standards in A level mathematics

The following issues were identified in the previous review of standards in A level mathematics, which compared examinations in 1998 and 2004.

- There were concerns about the coverage of assessment objectives (AOs). In particular the lack of coverage of AO2 (construction of mathematical proofs) was highlighted as a significant issue, with question papers considered to be too highly structured and not allowing for extended and rigorous argument. Furthermore, the balance of AO3 (use of mathematical models), AO4 (use of contexts) and AO5 (use of technology) was considered to be incorrect over the papers reviewed, especially within the pure mathematics papers.
- The number of possible routes through A level mathematics was considered to be too diverse, raising issues about comparability and causing potential confusion for centres and other users.
- There was an increase in demand due to increased examination time.

Materials available

Reviewers considered the syllabus documents, examiners' reports and question papers with associated mark schemes from each of the awarding bodies in 2004 and 2007. A list of the specifications reviewed can be found in Appendix A.

Assessment objectives

The AOs and their weightings were identical in 2004 and 2007 and are shown in Table 1.

Table 1: Assessment objectives in 2004 and 2007

Assessment objectives		Minimum weighting[2]
AO1	Recall, select and use knowledge of mathematical facts, concepts and techniques in a variety of contexts	30%
AO2	Construct rigorous mathematical arguments and proofs through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions, including the construction of extended arguments for handling substantial problems presented in unstructured form	30%
AO3	Recall, select and use knowledge of standard mathematical models to represent situations in the real world; recognise and understand given representations involving standard models; present and interpret results from such models in terms of the original situation, including discussion of the assumptions made and refinement of such models	10%
AO4	Comprehend translations of common realistic contexts into mathematics; use the results of calculations to make predictions or comment on the context; and where appropriate, read critically and comprehend longer mathematical arguments or examples of applications	5%
AO5	Use contemporary calculator technology and other permitted resources (such as formulae booklets or statistical tables) accurately and efficiently; understand when not to use such technology, and its limitations; give answers to appropriate accuracy	5%

[2]The weighting specified in the criteria only add up to 80 per cent because these are minimum weightings.

Between 2004 and 2007 there were changes to the AO allocations for each unit, and this was consistent across all awarding bodies. In the previous standards review report reviewers expressed concern that the pure mathematics papers did not cover adequately AO3 (use of mathematical models) and AO4 (use of contexts). Between 2004 and 2007 the awarding bodies moved a significant amount of the assessment of these objectives into the application papers, where they could be more easily assessed. In addition, the weighting for AO5 (use of technology) was reduced dramatically for C1, the non-calculator paper. The changes were broadly consistent across all awarding bodies. Reviewers judged that the 2007 papers reflected more accurately the requirements of AO3 and AO4. These changes were not regarded as altering demand over time but did represent improving practice. However, reviewers still considered that these AOs were not fully met overall, as many of the contexts of the questions, especially in the statistics papers, did not impact the mathematics required. Reviewers also welcomed the level of detail in the assessment grids by some of the awarding bodies in 2007, as this would have helped to ensure good coverage and consistent demand from one examination series to the next.

Reviewers judged that AO2 was still not thoroughly assessed in 2007. This AO requires construction of rigorous mathematical arguments and proofs, including the construction of extended arguments for handling substantial problems, which should be presented in unstructured form. Many of the pure papers in both 2004 and 2007 contained too great a proportion of highly structured questions, with very few unstructured questions requiring the construction of extended arguments. It was therefore difficult to see how the minimum requirement of 30 per cent of the overall marks could be allocated to AO2. This issue remained the same between 2004 and 2007 and so cannot be said to affect demand over time. Indeed, the same issue was raised in the reports on the previous standards reviews in GCE mathematics.[3] Reviewers also judged that the coverage of AO2 was not consistent between awarding bodies and that it affected the demand across awarding bodies in 2004 and 2007. In both years the papers from AQA were the most highly structured, with very few questions that could be said to provide candidates with opportunities for developing extended arguments, whereas the papers from CCEA offered extended questions in an unstructured form, allowing candidates to demonstrate more clearly their ability to handle the requirements of AO2. These differences led to variations in demand across the awarding bodies. This pattern was consistent between 2004 and 2007.

[3] *Review of standards in mathematics: GCSE 1999–2004 and A level 1998–2004* (QCA, 2006) and *A level Mathematics review of standards 1995–1998* (QCA, 2001)

The changes to AO coverage in 2007 represented improving practice. Overall however, while the changes in coverage led to greater consistency across the awarding bodies, they did not affect demand over time.

Syllabus content

By 2007 the C1 paper had been introduced. This paper was a response to the requirement to make AS more accessible from GCSE, as recommended in the Smith report[4], and in particular to those candidates who may have studied only intermediate tier at GCSE. To accommodate this extra paper, the pure mathematics content that had been covered previously by P1–P3 was divided into four new units C1–C4. The beneficial and intended effect of these changes was to make the AS more accessible from GCSE. To maintain the six-unit pattern, the number of applied modules was cut from three to two. This meant that a student who chose to study two different applications could gain an A level with four AS units and two A2 units. The effect of these changes was to reduce the content demand between 2004 and 2007. However, this reduction was counterbalanced by the introduction of unit C4, which will be discussed in the section on 'Demands caused by content changes' on page 11.

In addition, content was moved between units to make sensible groupings of topics. These varied across the awarding bodies. Although the content of units varied between awarding bodies, there was consistency across the AS and A2 units, for example the overall content of C1 + C2 remained consistent across awarding bodies, although the content of C1 varied. The regrouping of content in this way did not affect demand over time, but the overall effect was to increase consistency across awarding bodies.

As described above, AQA's model differed and spread the pure maths content across four units (Me, P1, P2 and P3.

Scheme of assessment

There was strong evidence of converging and improved practice between 2004 and 2007. The previous review of standards in GCE mathematics showed that the schemes of assessment differed significantly across awarding bodies in 1998.[5] By

[4] *Making Mathematics Count: The report of Professor Adrian Smith's inquiry into post-14 mathematics education* (DfES, 2004)

[5] *Review of standards in mathematics: GCSE 1999–2004 and A level 1998–2004* (QCA, 2006)

2004 the schemes of assessment were more uniform, but still differed between awarding bodies, with OCR offering many more optional routes than the other awarding bodies and AQA offering a compulsory mathematical methods paper.

In 2004 the general pattern was for candidates to take three AS units and a further three A2 units, so that the six units gave a full A level qualification. All candidates had to do three papers of pure mathematics, P1, P2 and P3. P1 was an AS unit, P2 contained material suitable for both AS and A2 units but was designated an A2 unit. P3 was an A2 unit. For AS mathematics, candidates had to do P1, P2 (an A2 unit) and one application unit at AS.[6] They had to do three further units, which could include a further AS application unit. Thus for AS mathematics, candidates took a unit designated as A2, and to complete their A level they usually included an AS unit.

By 2007 all awarding bodies offered the same scheme of assessment, making the differences much less marked. All candidates were required to sit two pure units (C1 and C2) plus an AS paper in one of mechanics, statistics or decision mathematics (except for CCEA and WJEC, neither of which offered decision mathematics). For A2 all candidates were required to take two pure units (C3 and C4), plus a second application unit. The major change was that a candidate could now choose a scheme with either three AS and three A2 units, or a scheme with four AS and two A2 units. Although the second option might at first appear to be ‘easier’, there are considerations to do with breadth versus depth, which are discussed in the section on 'Options' on page 9.

The length of examination time did not change significantly over the period. In 2004, with the exception of AQA, each unit was examined by a timed examination of 1 hour and 30 minutes which was the same in 2007. There were two minor exceptions to this pattern. OCR increased its unit examinations from 1 hour 20 minutes in 2004 to 1 hour 30 minutes in 2007, in line with the other awarding bodies. In 2004, all AQA question papers were 1 hour 20 minutes long and coursework was compulsory for some units. The 2007 AQA specification offered coursework as an option in the mechanics and statistics units, and in these cases the external examinations lasted 1 hour 15 minutes.

The changes in the schemes of assessment did not affect demand over time and represented converging practice by the awarding bodies.

[6]With the exception of AQA as described earlier.,

Options

All questions were compulsory on all papers in both years. However, there were optional routes in terms of combinations of papers. CCEA and WJEC did not offer decision mathematics in either year.

In 2004 only the three pure units were compulsory, but in 2007 there were four compulsory pure units, with choice limited to the two applied units. This led to much greater consistency between the routes offered by awarding bodies, with the only significant difference being the lack of decision mathematics in both CCEA and WJEC. This consistency did not affect the demand over time, but it did mean that it was easier for end-users to understand the structure of the qualifications, as shown in Table 3.

Table 3: Number of options available in 2004 and 2007

Awarding body	2004 AS	2007 AS	2004A level	2007 A level
AQA	3	3	5	6
CCEA	2	2	4	3
Edexcel	3	3	6	6
OCR	3	3	17	6
WJEC	2	2	5	3

As already noted, one of the key effects of the changes introduced between 2004 and 2007 was that the option of doing four AS units plus two A2 units became available across the awarding bodies.[7] While the demand of an A level made up of three AS plus three A2 units appears to be higher than an A level comprising four AS plus two A2 units, reviewers judged that the matter of breadth versus depth had to be taken into account. They considered that studying two different AS applications units requiring understanding of significantly different mathematical concepts was of equivalent demand to studying two units (one AS and one A2) in one application, and that this increased demand in terms of breadth offset the reduction caused by doing two AS units instead of one AS and one A2 unit.

[7]Detailed information on entry patterns can be found in the report *Evaluation of participation in GCE mathematics* (QCA, 2007).

Furthermore, in the applications, the A2 unit built significantly on the content of the AS unit, and so much less new ground was covered than when choosing two different applications. For example, a candidate doing S1 and S2 would study more statistics in S2 building on knowledge, skills and understanding acquired in S1, whereas a candidate doing S1 and M1 would need to acquire two different sets of knowledge, skills and understanding. Reviewers concluded that the option of doing four AS units plus two A2 units was not less demanding.

There was no evidence of any one of the applications being more demanding than the others. While reviewers found that mechanics units were often demanding in terms of the complexity of analysis needed and also required candidates to generate their own strategies to answer questions, they judged that statistics units were of equivalent demand because of the need to handle a high number of intricate calculations effectively and efficiently.

Overall, reviewers concluded that the demands caused by the range of options available remained constant over time, and the converging practice across awarding bodies was helpful to teachers and candidates. Reviewers also judged that there was no significant difference in demand between the optional routes available through the syllabuses in 2007.

Question papers

Time

As already noted, the total examination time for each awarding body remained the same over the period, with the exception of OCR and AQA, who slightly increased examination time to come into line with the other awarding bodies.

Structuring of questions

While this did not increase over the period, reviewers noted that many of the question papers were still highly structured and either led candidates through complex questions or suggested methods for solution as part of the question. Reviewers judged that it would be difficult to meet the required weighting for AO2 on many of the papers. There were also differences between awarding bodies in the degree to which complex questions were structured. In particular, AQA papers were very highly structured with very few questions where extended argument was possible. Reviewers judged that this reduced the demand of the papers, allowing much easier access for grade E candidates than on papers from other awarding bodies. By contrast, reviewers found that CCEA set some challenging, unstructured questions that raised the demand of the paper, although this was partially offset by concerns over mark allocations (discussed in the 'Mark schemes' section on page 11). As all of the above issues appeared in both 2004 and 2007, reviewers concluded that there

was no change in demand over time in this respect. However, they were concerned that insufficient attempts had been made to address the problem over the period and that these differences could have an impact on the performance of candidates, as seen at the script review.

Mark schemes

In general, the approach to marking was consistent, both across the awarding bodies and over the period, so reviewers judged that this had no effect on the demand of the question papers. There was, however, one exception. Reviewers found that the mark allocations per question for CCEA were more generous, with CCEA allocating more marks than other awarding bodes to very similar questions.

Overall, reviewers noted that there was evidence of improving practice over time across all awarding bodies, and in particular Edexcel, with more alternative solutions being outlined, better consistency in mark allocation and more detailed allocation. While this does not affect demand, it is good practice and helpful to teachers, as well as markers, and should lead to greater consistency of marking.

The higher level of structure in AQA papers, referred to in the 'Structuring of questions' section on page 10, was apparent in the mark schemes, with AQA using a significantly lower number of method marks compared to the other awarding bodies.

Layout

Reviewers considered that in general between 2004 and 2007 the design of question papers had improved, with clearer layout and higher quality diagrams. In addition, awarding bodies had attempted to make the language used in questions clearer and more accessible in terms of structure and vocabulary. While addressing such literacy issues does not affect mathematical demand, it makes the papers fairer and more accessible, especially for candidates who have English as an additional language, and forms an integral part of good practice in question paper setting.

Between 2004 and 2007 there was a significant growth in online marking and in the use of papers where candidates answer on question papers. This affected the layout of question papers, as questions had to become longer to allow sufficient space for candidates to answer. Reviewers were concerned that this was leading to more questions of more than two pages, making it difficult for candidates to refer back to questions. This had the effect of introducing a demand that was irrelevant to the assessment of mathematics.

Demand caused by content changes

The 'Syllabus content' section on page 7 refers to a reduction in demand caused by the loss of an A2 applied unit and the redistribution of the pure content from three units to four between 2004 and 2007. Counteracting this reduction in demand was

the introduction of the C4 paper, which was a complex and demanding paper and at least as challenging, if not more so, than an A2 applied option paper. Some parts of C1 were judged less challenging and more accessible than P1, as they were designed to be, although reviewers found that overall the differences were not significant. However, the gradient of difficulty from C1 to C4 was sharper than that from P1 to P3, with both C3 and C4 being at least the equivalent in demand of P3, with more synoptic material. Reviewers found that demand had been maintained at both AS and A2 and that, if anything, it had increased slightly at A2. Overall, they concluded that the reduction in content had been fully balanced by the rising demand of the papers and in particular the introduction of the rigorous C4 paper.

Consistency

In 2004, there were several papers where demand had been pitched at an inappropriate level, either too high or too low, and this was reflected in the grade boundaries. In 2007, question papers were more consistent, providing evidence of improving practice within the awarding bodies.

Coursework

In both 2004 and 2007 the only awarding body to offer coursework was AQA. In 2004 coursework was compulsory within mechanics and statistics. Coursework was offered as an option within mechanics and statistics units in 2007 and covered the same content as the alternative 100 per cent examination units. For units with coursework, the coursework contributed slightly less in 2007 than in 2004, reducing from 30 per cent to 25 per cent of the marks for the unit, while the contribution of the written examination increased correspondingly from 70 per cent to 75 per cent of the marks. Reviewers judged that these changes did not affect demand over time.

Summary

The changes in the syllabuses between 2004 and 2007 led to a greater consistency across the awarding bodies at both AS and A level. The number of possible routes through each syllabus became more consistent across the awarding bodies, which is helpful to teachers and candidates making choices in the transfer between GCSE and AS and to end-users of the qualifications.

The introduction of C1 helped increase accessibility and has gone some way to addressing the gap between GCSE and AS, as it was designed to do.

The decrease in content between 2004 and 2007 helped to address the issue of overfull content identified in the Smith report and led to a decrease in demand.

However, this was balanced by an increase in demand caused by the rigorous assessment of pure mathematics across four units and, in particular, on the C4 paper.

Some issues raised in the previous standards review report remained in 2007, in particular the over-structuring of questions by some awarding bodies and the limited coverage of AO2.

There was a welcome increase in consistency between awarding bodies and within their practice as a whole. There was evidence of good practice developing over the period.

Standards of performance

Reviewers considered candidates' work from all the awarding bodies in 2004 and 2007. Details of the materials used are provided in Appendix B.

Reviewers considered performance descriptions from the previous standards review report on GCE mathematics, which were based on candidate work seen from 2004. They considered these performance descriptions in light of 2007 candidate work seen and also referred to QCA's published AS and A2 performance descriptions for mathematics.

GCE AS grade A performance descriptor

AO1: The reviewers found evidence that candidates were secure in recalling knowledge, or selecting or using their knowledge over the range of papers. There was some evidence of secure success in extended algebraic manipulations, the process or application of calculus, sequences and coordinate geometry.

AO2: During testing, the reviewers found evidence that candidates were secure in constructing mathematical arguments and manipulating the majority of reciprocal mathematical expressions. When candidates were asked to show rigour they were able to develop logical arguments. There was evidence of extended use of precise mathematical statements.

AO3: During testing, evidence was found that candidates were secure in standard mathematics modelling and its assumptions or limitations. There was evidence of success in discussion or refinements or applied knowledge, although there were limited opportunities to demonstrate this.

AO4: During testing, the reviewers found evidence that candidates were secure in comprehending or interpreting realistic mathematical contexts. They were generally able to use results of calculations to draw conclusions about the context of the question.

AO5: The reviewers found evidence that candidates were secure in using calculators, formulae booklets or statistical tables. There was evidence of success in appreciating whether an answer was sensible or plausible. Candidates could handle surds well and understood the requirements of being exact.

Performance at GCE AS grade A over time

The performance of AQA, CCEA and OCR candidates was broadly comparable at this grade boundary between 2004 and 2007. For Edexcel and WJEC there was evidence of a decline in the standards of performance over the period. Reviewers commented that Edexcel and WJEC candidates in 2004 tended to demonstrate stronger performance on the pure mathematics papers, showing a greater range and depth of knowledge and more complex techniques.

Performance at GCE AS grade A across the awarding bodies in 2007

The performance of candidates was broadly comparable across all awarding bodies at this grade boundary.

GCE AS grade E performance descriptor

AO1: The reviewers found evidence that candidates were generally secure in differentiation and integration of polynomials, straight line coordinate geometry and completing the square for expressions of the form x^2+bx+c. There was some evidence of success in algebraic manipulation (including quadratic equations), sketching graphs and their transformations and non-right-angled triangle trigonometry. Candidates at this level were, in general, prompted by the question into a method.

AO2: There was some evidence of success in (algebraic) manipulation of mathematical expressions. There was some evidence that rote learning of standard proofs (eg summation of arithmetic, geometric progressions, differentiation from first principles) had taken place. There was little evidence of independent thinking and reasoning.

AO3: There were very few opportunities for modelling in C1 and C2. When such opportunities came about (including the applications units) they were inaccessible to candidates at this level unless there was strong direction towards implementation of a particular technique.

AO4: There were some opportunities to make predictions or comment on the context (mainly in applications units), and provided these were sufficiently explicit, candidates showed evidence of success in this aspect.

AO5: There was consistent evidence of efficient use of a calculator for mathematical purposes. However, not all candidates at this level made effective use of a graphical calculator. Use of the formulae booklets was mixed, with some good practice

involving trigonometric equations and some poor practice involving the trapezium rule.

Performance at GCE AS grade E over time

For AQA, CCEA and OCR standards of performance were broadly comparable at this grade boundary between 2004 and 2007. However, for Edexcel and WJEC there was a decline in the standards of performance and this was more marked than at AS grade A. Again, reviewers commented that Edexcel and WJEC candidates in 2004 showed greater breadth and depth of mathematical understanding and skills on the pure mathematics papers than their 2007 counterparts.

Performance at GCE AS grade E across the awarding bodies in 2007

The performance of candidates was broadly comparable between CCEA, Edexcel and OCR at this grade boundary. However, AQA candidates were judged to be stronger, while WJEC candidates were generally found to demonstrate weaker performance. While the performance of WJEC candidates was often comparable to candidates from other awarding bodies in the statistics unit, reviewers judged that WJEC candidates showed less breadth and depth of knowledge and skills on C1 and C2, where their performance was often inconsistent. Reviewers commented that AQA candidates tended to show a wider range and greater depth of knowledge and skills on C1 and in particular C2. Reviewers also noted that the AQA question papers were more structured and that this made them more accessible to weaker candidates, allowing them to demonstrate their knowledge, understanding and skills. However, it must be noted that reviewers judged the structuring to be excessive and thus not providing adequate evidence of candidates' ability to produce rigorous mathematical arguments (AO2).

GCE A level grade A performance descriptor

AO1: Candidates displayed a sound grasp of facts, concepts and techniques associated with work at A2. They could correctly recall most of the relevant formulae, for example double angle formulae in core mathematics and a range of formulae in mechanics. They were not always given a range of opportunities to demonstrate their ability to cope with unstructured questions (and reviewers identified clear differences between the awarding bodies in this respect). Work in context was mainly confined to the applications units, and here the contexts were mostly standard. Their grasp of most concepts relevant to A2 was sound. They occasionally made slips in calculations and algebra, but were generally able to work accurately and keep control of extended solutions when these were required.

AO2: Candidates were given limited opportunities to display the ability to construct logical chains of reasoning. Some applications units required multi-step arguments that were generally handled well, but again opportunities were limited by the structuring of the questions. Candidates could solve most equations, both algebraic and trigonometric, although there was some evidence that when algebraic manipulation was incidental to the question rather than the focus, candidates found it difficult to transfer and use that skill. They generally showed confidence in manipulating expressions, although there was some evidence that this skill had deteriorated since 2004. There was no strong evidence ofany change in candidates' use of notation.

AO3: When tested, candidates continued to be able to work confidently with familiar and some unfamiliar models, such as probability distributions in statistics and the construction of differential equations. There was little evidence that candidates were able to discuss limitations and assumptions effectively or to suggest refinements. During testing, the questions proved good discriminators at this boundary. There was some evidence of an improvement in this area since 2004.

AO4: Candidates continued to be able to interpret their answers in the context of the question, although again opportunities to display this skill were limited.

AO5: Candidates generally used the permitted resources efficiently and accurately, although graphics calculators were not always used to their full capabilities, either to sketch graphs or to exploit their capacities for iteration. The statistics functions in particular were used accurately. Candidates continued to give answers to an appropriate degree of accuracy or as exact values where appropriate, and there was some evidence of an improvement in this area since 2004.

Performance at GCE A level grade A over time

There was general evidence of an increase in the standards of performance at this grade boundary, in particular for OCR and, to a lesser extent, for AQA and WJEC. The performance of CCEA candidates was generally found to be comparable over the period, while that of Edexcel candidates had, if anything, declined slightly.

Reviewers commented that AQA, OCR and WJEC candidates demonstrated more consistent knowledge and understanding and a wider range of manipulative skills in the pure mathematics papers in 2007 and that they produced more consistently convincing solutions. Reviewers found that OCR candidates in 2007 performed better than their 2004 counterparts on similar questions, as well as showing a wider range of skills and knowledge. In the case of AQA, reviewers also commented on candidates' performance in the M2 unit in 2007, noting that candidates showed a good grasp of mechanical principles and sound extended arguments.

Performance at GCE A level grade A across the awarding bodies in 2007

The performance of candidates was broadly comparable across Edexcel, OCR and WJEC at this grade boundary. However, AQA candidates were judged to be stronger, while CCEA candidates were generally found to demonstrate weaker performance. Reviewers commented that AQA candidates showed consistently greater range and depth of knowledge and understanding across all units, and particularly on the mechanics unit. CCEA candidates demonstrated less secure and sophisticated knowledge, and their performance was less consistent across all areas, in particular the mechanics unit. Reviewers judged that the performance of AQA candidates was enhanced by the highly structured question papers, which offered candidates considerable support. By contrast, they considered that the CCEA question papers were demanding in that they contained more unstructured questions, requiring candidates to construct their own extended arguments. These findings reflect the conclusions of the syllabus review, which noted an increase in the scaffolding of questions in AQA papers, further undermining the requirements of AO2 (construction of mathematical arguments and proofs).

GCE A level grade E performance descriptor

AO1: Candidates were generally secure in their use of mathematical facts and techniques. There was evidence of success in knowledge of mathematical concepts, the ability to apply techniques in a variety of contexts and the ability to determine which facts/skills were required. Candidates were not always able to apply their knowledge within the given context.

AO2: There was some evidence of success in the ability to manipulate mathematical expressions across a number of topics.

AO3: Candidates were generally secure in recalling, selecting and using simple standard mathematical models although less confident in non-standard models. They quoted standard assumptions about given models, although there was more limited evidence of an understanding of these assumptions.

AO4: In so far as it was tested, there was some evidence of success in the understanding and use of contexts, mainly in the applications units.

AO5: Candidates were generally secure in using calculators to perform basic calculations accurately.

Performance at GCE A level grade E over time

There was evidence of a general and very marked increase in the standards of performance across all awarding bodies at this grade boundary. Reviewers commented that candidates performed better in the pure mathematics papers in 2007. There was more evidence of sound basic working and more complete methods. Candidates demonstrated greater depth in their algebra, with a greater range of techniques. Reviewers commented that candidates in 2007 performed better on similar questions, for example on partial fractions, than their 2004 counterparts.

Reviewers commented on the positive impact of the syllabus changes made between 2004 and 2007 on standards of performance. They were reassured that the changes had generated an improvement in standards of performance and that candidates were producing better mathematics to obtain a grade E than in 2004.

Performance at GCE A level grade E across the awarding bodies in 2007

There were no CCEA candidates available at this grade boundary. The performance of candidates was comparable between Edexcel and WJEC. AQA candidates were judged to be stronger, while OCR candidates were found to demonstrate weaker performance.

Reviewers commented that AQA candidates were more consistent across a range of topics and that their performance in C3 and especially in M2 was often stronger. Again, reviewers noted that the AQA question papers were more structured than those from other awarding bodies, in particular in M2, and that this enhanced candidates' performance by giving them more support and making it easier for them to show what they could do. OCR candidates showed less breadth of knowledge and a weaker grasp of basic concepts, especially on the core units, and their work contained more fundamental errors. Reviewers commented that the OCR core units were pitched at a demanding level and had a shallow gradient of difficulty, with relatively few easily accessible marks and that this made the papers especially challenging for weaker candidates.

Summary

Comparing standards of performance between 2004 and 2007, reviewers found that at AS grades A and E, standards were comparable for AQA, CCEA and OCR. However, there was evidence of a decline in standards of performance for Edexcel and WJEC candidates over the period, and this decline was particularly marked at AS grade E.

At A level the picture was rather different. At grade A reviewers found evidence of a general increase in the standards of performance, in particular for OCR and, to a lesser extent, for AQA and WJEC. The performance of CCEA candidates was comparable over the period. At grade E there was evidence of a general and very marked increase in the standards of performance across all awarding bodies between 2004 and 2007, and reviewers attributed this particularly to better performance on the pure mathematics papers.

Comparing standards of performance across the awarding bodies in 2007, reviewers judged performance to be broadly comparable at AS grade A. At AS grade E, standards of performance were comparable across CCEA, Edexcel and OCR, with AQA candidates judged to be stronger and WJEC candidates weaker.

At A level grade A in 2007, standards of performance were comparable across Edexcel, OCR and WJEC, with AQA candidates found to be slightly stronger and CCEA candidates judged slightly weaker. At A level grade E performance was found to be comparable across Edexcel and WJEC, with AQA candidates again found to be slightly stronger and OCR candidates weaker. These findings may have been in part attributable to AQA setting more structured question papers, while CCEA included some challenging and unstructured questions.

Overall, reviewers were reassured that syllabus changes between 2004 and 2007 had ensured that standards had generally been maintained at AS and that at A level, the revised schemes of assessment, and in particular the rigorous C4 paper, had allowed candidates to provide more consistent evidence of their mathematical understanding and skills.

Appendix A

Syllabus codes of A level mathematics syllabuses reviewed

Year	Awarding body and syllabus				
	AQA	**CCEA**	**Edexcel**	**OCR**	**WJEC**
2004	5301/6301	A2210	8450/9450	3840/7840	7790
2007	5361/6361	A2211	8371/9371	3890/7890	4790

Appendix B

Number of A level mathematics scripts reviewed

	AQA		CCEA		Edexcel		OCR		WJEC	
	2004	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**
AS(A)	10	10	8	8	9	9	10	10	10	10
AS(E)	4	10	8	3	10	10	10	9	10	10
A2(A)	10	10	8	10	10	9	8	9	5	10
A2(E)	3	10	6	0	10	8	8	8	4	9

Appendix C

List of reviewers

Review team	
Co-ordinator	Pat Morton
Syllabus reviewers	Claire Baldwin Kevin Wallis Andrew Rogers
Script reviewers	Peter Woods (QCA appointed) Rob Summerson (QCA appointed) Stephen Handley (QCA appointed) Ken Barley (OCR nominee) Jim Miller (AQA nominee) Dr Howard Thomas (WJEC nominee) Sara Neil (CCEA nominee) Jennie Golding (The Mathematical Association) Frankie Teague (Association of Teachers of Mathematics) Peter Thomas (Advisory Committee on Mathematical Education)

Appendix D

Descriptions of performance used to describe work during the 2004 review

GCE AS grade A

AO1: The reviewers found evidence that candidates were generally secure in recalling knowledge and selecting and using their knowledge over the range of papers (particularly in mechanics). There was some evidence of success in algebraic manipulation and the use of calculus.

AO2: During testing, the reviewers found evidence that candidates were generally secure in constructing mathematical arguments reproducing standard proofs and manipulating mathematical expressions. There was some evidence of success in extended arguments.

AO3: During testing, the reviewers found evidence that candidates were generally secure in standard mathematical modelling, its assumptions and limitations (mainly in the applied units). There was some evidence of success in discussion and refinement, and applied knowledge (although there were few opportunities to demonstrate this).

AO4: During testing, the reviewers found evidence that candidates were generally secure in comprehending realistic mathematical contexts and using results of calculations to make predictions (but only in mechanics papers). There was some evidence of success in longer arguments (in the applications papers).

AO5: The reviewers found evidence that candidates were generally secure in using calculators and other resources accurately and efficiently. There was some evidence of success in appreciating whether an answer was sensible or plausible and appropriate rounding.

GCE AS grade E

AO1: The reviewers found evidence that candidates were generally secure in straight-line coordinate geometry. There was some evidence of success in simple algebra and trigonometry, the binomial theorem, indices and log, integration and differentiation, plotting of graphs, calculus and number concepts.

AO2: During testing, the reviewers found evidence that candidates were generally secure in the manipulation of mathematical expressions. There was some evidence of success in rigorous mathematical arguments and in reproducing standard proofs.

AO3: During testing, the reviewers found that there was some evidence of success in modelling (in the application units).

AO4: During testing, the reviewers found that there was some evidence of success in the use of the results of calculations to make predictions and understanding applications.

AO5: The reviewers found evidence that candidates were generally secure in using calculators and other resources. There was some evidence of success in giving answers to appropriate accuracy.

GCE A level grade A

AO1: The reviewers found evidence that candidates were generally secure in recalling a wide range of knowledge and selecting and using their knowledge over the range of papers. There was some evidence of success in using context (but only in applications units).

AO2: During testing, the reviewers found evidence that candidates were generally secure in manipulating expressions and constructing extended arguments (particularly in the mechanics papers). There was some evidence of success in the ability to handle unstructured questions.

AO3: During testing, the reviewers found evidence that candidates were generally secure in their ability to construct accurate models (particularly in the applications units),in their use of standard mathematical models and in their understanding that models were constrained by the assumptions made about them. There was some evidence of success in interpretation and discussion and refinement.

AO4: During testing, the reviewers found evidence that candidates were generally secure in comprehending translations of common realistic contexts into mathematics (in the applications units) and in reflecting on results (in the applications units). There was some evidence of success in making predictions and commenting on the context.

AO5: The reviewers found evidence that candidates were generally secure in using calculators and other resources accurately, in efficiently appreciating whether an answer was sensible or plausible and in appropriate rounding.

GCE A level grade E

AO1: The reviewers found evidence that candidates were generally secure in their use of mathematical facts and techniques. There was some evidence of success in knowledge of mathematical concepts, in the ability to apply techniques in a variety of contexts and in the ability to determine which facts/skills were required.

AO2: The reviewers found that there was some evidence of success in the ability to manipulate mathematical expressions.

AO3: The reviewers found evidence that candidates were generally secure in recalling, selecting and using simple standard mathematical models and in quoting learned assumptions about given models. There was some evidence of success in the ability to interpret results and to discuss assumptions and refinements.

AO4: The reviewers found that there was some evidence of success in the understanding and use of contexts (but only in the applications units).

AO5: The reviewers found evidence that candidates were generally secure in using calculators to perform basic calculations with accuracy and efficiency.

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