Qualifications and Curriculum Authority

Review of standards in mathematics: GCSE 1999–2004 and A level 1998–2004

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Contents

1. Introduction

In 2001, QCA published reviews of standards over time in GCSE mathematics between 1995 and 1999 and in A level mathematics between 1995 and 1998. The results were published in reports that are available on the QCA website (www.qca.org.uk). The key issues identified by the reviews were considered as part of the work on this current review.[1]

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 within the *Review of qualifications for 16–19 year olds* (1996) led by Lord Dearing. The programme of reviews also followed on from an investigation of standards in a restricted number of subjects (including mathematics) by SCAA and the Office for Standards in Education – published in 1996 in *Standards in public examinations 1975–1995.*

Unlike the earlier reviews, this review considers GCSE and AS/A level at the same time, thus providing the opportunity to consider the issue of progression between GCSE and AS/A level in terms of coverage of topics and the development of skills.

Between them, the GCSE syllabuses in this review attracted about 74 per cent of the 747,000 candidates who took GCSE mathematics in 2004. The A level syllabuses included in this review attracted about 78 per cent of the 50,260 candidates who took A level mathematics in 2004.

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

[1] A recent report, *Making mathematics count* (2004), details the results of an enquiry into post-14 mathematics education. Led by Professor Adrian Smith, the enquiry had a very wide brief and made many recommendations, some specific to GCSE and A level. These recommendations are not addressed systematically in the current review.

2. Key findings from previous reviews of GCSE mathematics

The following key issues emerged from QCA's review of standards over time in GCSE mathematics between 1995 and 1999 and from the SCCA and Ofsted's review of standards between 1975 and 1995.

Tiering

The 1975–95 review recommended that the content and demand associated with the higher and intermediate tiers should provide suitable preparation for further study.

Manipulative algebra

By 1999, examination papers gave increased emphasis to the skills of algebraic manipulation, in line with the recommendation made in the 1975–95 review. However, the reviewers noted that the ability to model a mathematical situation algebraically was not assessed effectively in 1999.

Multi-step problem solving

By 1999 there had been an increase in the proportion of questions demanding the unprompted solution of multi-step problems, and there were some unstructured problems in 1999 question papers at all tiers.

Use of calculators

The 1975–95 review made two recommendations regarding the use of calculators. One was that there should be 'some demanding mathematical tasks which require candidates to demonstrate effective use of the capabilities of calculators', and the parallel recommendation was that some papers should be completed without the use of a calculator. By 1999 neither of these recommendations had been fully met.

Formulae sheets

The 1975–95 review recommended that there should be agreement on the 'wider range of formulae that candidates for different tiers should be able to recall'. By 1999 a common formulae sheet had been introduced which affected some awarding bodies more than others, although CCEA still provided very few formulae. The review noted that loose-leaf formulae sheets may have been the most helpful to candidates.

The use of contexts

The 1995–99 review recommended that thought be given to the use of context within examination papers: ‘It should be purposeful, giving purchase on the mathematics at one end of the spectrum and increasing demand at the other.’ The review also noted that it was appropriate that a significant proportion of questions should be free of context.

Assessment of Ma1

The 1995–99 review noted some variation between and within awarding bodies in the optional routes for assessing Using and applying mathematics (Ma1).

3. Standards in GCSE mathematics 1999–2004

The main changes to GCSE mathematics examinations between 1999 and 2004 were:
- the introduction of explicit testing with and without the use of a calculator;
- the extension of the coursework element to include assessment of two assessment objectives rather than one.

In addition, the subject criteria were slightly amended to reflect changes in the national curriculum, and awarding bodies that had made use of an aural component in 1999 had removed the assessment by 2004.

Examination demand

Materials available

The reviewers considered the syllabus documents, examiners' reports and question papers with associated mark schemes from each of the awarding bodies in1999 and 2004. Details of the syllabuses included in the review are given in Appendix A.

Assessment objectives

The assessment objectives have remained broadly the same through the period: Using and applying mathematics (AO1 – 20 per cent), Number and algebra (AO2 – 40 per cent), Shape, space and measures (AO3 – 20 per cent), Handling data (AO4 – 20 per cent). There has, however, been a shift in the way that they are addressed.

In 1999, AO2, AO3 and AO4 were tested in written papers and AO1 through the coursework. In 2004, assessment of AO1 and AO4 was split half and half between written papers and coursework in each case. This allowed AO4 to be addressed in a more practical context. The change resulted in written papers that included significant elements assessing AO1, while the coursework in 2004 comprised two quite distinct pieces of work. Both effects were judged to involve an increase in demand.

The reviewers judged that the 2004 syllabuses gave a better coverage than those in 1999 over a wider range of skills. However, they expressed some concern over the resulting increase in demand.

Syllabus content

All the 2004 syllabuses made an explicit reference to progression from key stage 3.

The reviewers commented on a general but mostly minor movement in specific mathematical topics, particularly between tiers, resulting mainly in an increase in the number of topics in the lower tiers. The overall topic content remained broadly the same between 1999 and 2004. The reviewers judged that the step up from the intermediate to the higher tier was a bit more severe than that from foundation to intermediate tier. This was also reflected in the question papers (see the 'Tiering' section below).

The reviewers also noted that WJEC included an option in 1999 (Syllabus B, Paper 3) that was considered to be very demanding. The option had been dropped in 2004.

Schemes of assessment

The following table shows the schemes of assessment in 1999.

	Tier	Type of assessment (weightings in brackets)		
		Aural tests	**Written papers**	**Coursework**
	Foundation	Aural test 20 mins (5%)	Two written papers 3 hrs (75%)	Coursework (20%) *Or* awarding body set tasks (20%) No time specified
	Intermediate/ higher	Aural test 20 mins (5%)	Two written papers 4 hrs (75%)	Coursework (20%) *Or* awarding body set tasks (20%) No time specified
CCEA	Foundation/ intermediate	Aural test 30 mins (10%)	Two written papers 3 hrs (70%)	Coursework (20%) *Or* terminal task (20%) 1 hr (foundation), 1 hr 30 mins (intermediate)
	Higher	Aural test 30 mins (10%)	Two written papers 5 hrs (70%)	Coursework (20%) *Or* terminal task (20%) 2 hrs
Edexcel	Foundation	–	Two written papers 3 hrs (80%)	Coursework (20%) *Or* terminal tasks (20%) 2 hrs (foundation/ intermediate)

	Intermediate/ higher	–	Two written papers 4 hrs (80%)	Coursework (20%) *Or* terminal tasks (20%) 2 hrs 30 mins
OCR	Foundation	–	Two written papers 3 hrs (80%)	Awarding body set tasks (20%) 3 hrs + preparation time
	Intermediate/ higher	–	Two written papers 4 hrs (80%)	Awarding body set tasks (20%) 3 hrs + preparation time
WJEC	Foundation	–	Two written papers 3 hrs (80%)	Coursework (20%) *Or* written paper (20%) 1 hr 30 mins
	Intermediate	–	Two written papers 4 hrs (80%)	Coursework (20%) *Or* written paper (20%) 2 hrs
	Higher	–	Two written papers 4 hrs 30 mins (80%)	Coursework (20%) *Or* written paper (20%) 2 hrs 15 mins

CCEA had a more demanding scheme of assessment than the other awarding bodies, particularly at the higher tier. These candidates had the longest overall examination time (five hours) on two written papers that carried the lowest weightings (35 per cent for each paper, compared with 37.5 per cent or 40 per cent for the other awarding bodies). CCEA's aural test also carried the highest weighting, worth 10 per cent of the overall marks.

In 1999 there was some variation across the awarding bodies in terms of the use of calculators. OCR had one calculator paper and one non-calculator paper at each tier, the only awarding body to do so at this time. AQA and CCEA had aural papers, designed to test candidates' mental calculations, and calculators were not permitted in these. Edexcel and WJEC had a similar approach to the use of calculators. Each included a reference to the use of calculators in their syllabuses and stated that there would be some questions where the use of calculators would be prohibited. Edexcel's papers 1F and 3I each contained one question in which candidates were instructed not to use calculators. The equivalent higher-tier paper (5H) did not contain such a question. WJEC included a non-calculator question or part of a question on each paper except 1H. It was unclear how Edexcel and WJEC ensured that candidates did not use calculators when answering these questions, as candidates were allowed calculators for the rest of these papers.

All awarding bodies except OCR offered an alternative to coursework in the form of tasks set and marked by the awarding body. OCR did not offer the coursework alternative. WJEC offered an externally set paper as an alternative to coursework, which was judged to be demanding in comparison with the awarding body set and marked tasks seen by OCR and Edexcel.

The schemes of assessment in 2004 are shown in the following table.

	Tier	**Type of assessment (weightings in brackets)**	
		Written papers	**Coursework**
AQA	Foundation	One non-calculator and one calculator paper 3 hrs (80%)	Coursework (20%)
	Intermediate/ higher	One non-calculator and one calculator paper 4 hrs (80%)	Coursework (20%)
CCEA	Foundation/ intermediate	One non-calculator and one calculator paper 3 hrs (80%)	Coursework (20%)
	Higher	One non-calculator and one calculator paper 4 hrs (80%)	Coursework (20%)
Edexcel	Foundation	One non-calculator and one calculator paper 3 hrs (80%)	Coursework (20%)
	Intermediate/ higher	One non-calculator and one calculator paper 4 hrs (80%)	Coursework (20%)
OCR	Foundation	Two module tests* 2 hrs (30%)	Coursework (20%)
		One terminal test* 2 hrs (50%)	

	Intermediate/ higher	Two module tests* 2 hrs (30%)	
		One terminal test* 2 hrs (50%)	
WJEC	Foundation	One non-calculator and one calculator paper 3 hrs (80%)	Coursework (20%)
	Intermediate/ higher	One non-calculator and one calculator paper 4 hrs (80%)	Coursework (20%)

*In the OCR tests the first half of each timed test was non-calculator, while in the second half calculators were allowed.

By 2004, the use of calculators had become much more consistent, with each awarding body having one calculator and one non-calculator written paper at each tier. AQA and CCEA had dropped their aural papers.

As is clear from the table, OCR's scheme of assessment in 2004 was rather different from those of the other awarding bodies. The reviewers judged that OCR's scheme was more demanding than those of the other awarding bodies at each tier.

The reviewers found that the foundation tier had become a bit more demanding in 2004, although not unreasonably so. This was partly brought about through the changes to the coursework element. Also, the non-calculator paper at the foundation tier was considered to increase the demand on these candidates.

Options

In 1999 all awarding bodies except OCR offered a choice between coursework and an alternative. In the case of WJEC this took the form of an externally set question paper, which reviewers judged to be particularly demanding, as noted above. AQA, CCEA and Edexcel offered awarding body set and marked tasks as an alternative to coursework. OCR had no centre-marked coursework option, and all candidates had to do awarding body set and marked tasks. By 2004 none of the syllabuses allowed any degree of choice beyond which tier to enter, whether in the components taken or within the question papers.

Question papers

The reviewers commented that all awarding bodies' question papers were more accessible linguistically in 2004 than in 1999. They thought that as a result there was less room for confusion among candidates in 2004 than in 1999: in 2004 it was very firmly the mathematics that was being tested. The reviewers also judged the tasks in 2004 to be more clearly laid out, making them more accessible. This increase in transparency applied to all the awarding bodies.

There were small changes over the period in the number of marks per examination minute and in the way marks were assigned to the various tasks. These were not considered to affect demand, but it was noted that candidates at the foundation tier would be likely to feel more positive about their experience of the examination as a result of the changes.

The questions were essentially closed. The tasks were clear and generally more user-friendly in 2004 than in 1999. It was noted that this change was very marked in OCR's papers. This awarding body's 1999 questions were often embedded in a wide range of contexts, largely for the sake of variety rather than to provide transparency and aid understanding.

The increased level of abstraction and algebraic manipulation noted in the 1999 report had risen further at the higher tier in 2004.

When calculators were permitted, the tasks were clear. However, the review of performance highlighted some problems with candidates' use of calculators (see the 'Standards of performance' section below.)

In 2004 there had been some minor changes in the overall total time available for completion of question papers, but the reviewers did not consider that time pressure would be a significant issue for candidates. Similarly, the difference in total examination time for the different tiers was judged to be appropriate.

Tiering

All syllabuses in both 1999 and 2004 used a three-tier structure as defined in the subject criteria. The overall grades available at the various tiers were A*–C (higher), B–E (intermediate) and D–G (foundation).

The 1995 review highlighted the need for an increased emphasis on algebra, which the review in 1999 noted had been met across all tiers. In 2004, the reviewers found that the levels of algebraic manipulation had risen steeply through the tiers. They judged this to be appropriate given the need for the higher tier to prepare candidates for the demands of A level.

The reviewers judged that the step from the intermediate to the higher tier was more severe than that from the foundation to the intermediate tier, and that this difference had become more marked since 1999. This was associated not only with the greater demands in algebraic manipulation, but also with an increased level of abstraction and at least some strategic thinking at the higher levels.

Coursework

Between 1999 and 2004 there was a significant shift in coursework requirements. Candidates in 2004 had to produce two distinct pieces of work: one in Using and applying mathematics (AO1) and one in Handling data (AO4). In 1999, candidates' marks could be awarded on a single piece of work (although they were nominally required to produce two), and all work focused on AO1.

The reviewers judged that these changes had increased the overall demand. They also noted that the written reports candidates had to produce made the coursework requirements more demanding, without necessarily affecting the mathematical demand of the tasks. However, the reviewers also noted that the change of emphasis allowed a greater range of skills to be explored and tested, at least in principle.

Summary

- The 'strong evidence of converging practice' across the awarding bodies – remarked upon in the 1999 review – has continued.
- The recommendation in 1995 for an increased emphasis on algebraic skill has been effected across all tiers.
- Similarly the 1995 review's recommendation for non-calculator papers has been effected, although the reviewers questioned whether it was appropriate at foundation tier.
- Question papers were generally much clearer in 2004 than in 1999 and allowed a better assessment of mathematics. The use of trivial or distracting context, noted in the 1999 report, had been reduced, especially in OCR's papers.
- Syllabus content provided a good basis for progression from the higher tier to A level. This was not true for the intermediate tier.[2] (See the 'Standards of performance' section.)

[2] The Smith report, *Making mathematics count*, recommends a move to a two-tier system, and two different models for such a system are currently being piloted.

- Changes to the coursework were generally welcomed as a way to address practical and contextual issues. However, the shift in emphasis has added to the overall level of demand.

4. Key findings from previous reviews of GCE A level mathematics

QCA's review of standards over time in GCE mathematics between 1995 and 1998 found little evidence that recommendations from the SCAA/Ofsted review of standards between 1975 and 1995 had been addressed. However, it should be noted that insufficient time had elapsed for awarding bodies to implement recommendations involving structural changes to syllabuses. On three of the original recommendations there was no further comment in the 1995–98 review, as the recommendations required changes that could only have been made during criteria and syllabus revision, which took place as part of the Curriculum 2000 reforms. All the recommendations are explored further in this report in subsequent sections.

Syllabus content

'Sufficient emphasis should be given to algebraic manipulation'. The 1995–98 review found no evidence of an increase in the requirements for algebraic manipulation. Scrutiny of candidates' work at the script review corroborated this perception and suggested that actual performance in this area had, if anything, declined.

'Appropriate topics from the pure mathematics section of the 1983 Common Core should be reintroduced.'

Examining techniques

'The degree of structuring in examination questions should be limited, in order to ensure sufficient discrimination between the higher grades.' The 1995–98 review found little evidence of change between 1995 and 1998 in the amount of structuring and noted that structuring had, if anything, increased. The script review suggested that the level of structuring in 1998 made it difficult for candidates to demonstrate their ability to carry out a multi-stage solution.

'More emphasis should be placed in examinations on reasoning and problem-solving'. The reviewers found no evidence of attempts to introduce more reasoning into written examinations by 1998, although some questions did require some problem-solving, particularly in mechanics papers.

Use of formulae sheets and calculators

'Agreement should be established on a set of formulae that candidates should be expected to know.'

‘There should be strict limits on the use of calculators in certain papers.’

5. Standards in A level mathematics 1998–2004

The major issue that affected all A level examinations between 1998 and 2004 was the change in design of the A level qualification in line with the Curriculum 2000 reforms. This involved a move to unitised assessment based on a six-unit structure. The overall assessment of the A level qualification was split into the first half, called advanced subsidiary (AS), and the second half, A2. The AS and A2 sections of the course were each assessed through three units, making six units for the A level overall. The level of demand of the AS qualification was reduced from the former advanced supplementary qualification, to allow a smoother transition for students moving from GCSE to A level and to allow the new AS to stand as a 'broadening' qualification in its own right. The main requirement of the changes was to carry forward the full A level standard.

The most significant changes to A level mathematics examinations between 1998 and 2004 were:

- increased modularity, largely associated with the introduction of Curriculum 2000;
- a generally welcome attempt to make the subject more accessible and attractive to students, particularly through an emphasis on understanding and applications, together with increasing students' awareness of the subject's importance for higher education and for employment. This attempt goes some way towards resolving the potential conflict between mathematics for direct applications, for transferable skills and for its own sake.

A level syllabuses in 1998 had been developed in line with the relevant subject core; those in 2004 conformed to requirements of the Curriculum 2000 subject criteria.[3]

Examination demand

Materials available

The reviewers considered the syllabus documents, question papers and associated mark schemes from each of the awarding bodies in 2004 and all except those from OCR in 1998. Details of the syllabuses included in the review are given in Appendix A.

Assessment objectives

The assessment objectives have very similar overall content in the two years in this study. However, they had been made a little more specific in 2004. Reviewers noted a lack of

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[3] The subject criteria and syllabuses developed for first teaching in 2004 had been further revised to improve manageability for centres.

consistent coverage of assessment objectives across units in that year. The extent to which the assessment objectives are covered depends on the combination of options chosen. In particular, AO3, AO4 and AO5, which involve real contexts and calculator use, were scarcely tested at all in the pure mathematics units. In 2004 there was also not much evidence of the construction of rigorous arguments or unstructured problems referred to in AO2.

The reviewers noted the difference in philosophy between the GCSE assessment objectives and those for A level. Those for GCSE are content-specific; those for A level are more qualitative, promoting particular skills and attitudes. This has some implications for progression from GCSE to A level, in that the level of abstraction is higher for AS level candidates and it requires a more mature outlook on their part.

Syllabus content

The subject content explicitly built on key stage 4, so that there is a clear line of progression from GCSE content. However, while this would be a comfortable transition for students who had done well at the GCSE higher tier, those who had achieved grade C at the intermediate tier would have to cover some extra topics in order to progress to AS level study. This transition would be likely to prove difficult for them.

The overall number of topics was about the same in 1998 and 2004, although there was a slight reduction in content in some. By 2004 there was an agreed set of formulae that candidates were expected to know, common to all awarding bodies. This meant that the content of formula booklets had been reduced and candidates were required to know more formulae. This increased the demand, in particular at AS level.

A significant outcome of all syllabuses becoming modular is that, for example, mechanics could be omitted completely in 2004, whereas in at least AQA’s syllabus in 1998 it could not. This has implications for higher education courses in mathematics, science and engineering.

Increased modularity has another consequence. The only manipulative mathematics techniques required in the AS applications units were those developed for the early pure units. This made the techniques involved less complex than used to be the case.

Content topics were moved in both directions – for example, some mechanics topics were moved to higher units, but some pure topics moved in the opposite direction. Where topics were now in earlier units, this increased the demand but resulted in the topic being tested in slightly less depth.

The coverage of statistics remained very similar from 1998 to 2004. The reviewers considered it somewhat formulaic, in particular where questions involved the interpretation of results.

Schemes of assessment

In 1998, the schemes of assessment differed significantly between awarding bodies. This was partly because the WJEC syllabus was linear, whereas the CCEA and Edexcel ones were modular, and AQA's was a mixture of the two. Both the modular schemes had four equally weighted units. In both these syllabuses, too, candidates took two compulsory units of pure mathematics and two further units at least one of which had to be an applications unit. In the linear WJEC syllabus, candidates took a compulsory paper of pure mathematics, weighted at 50 per cent, together with a further applications paper. The AQA syllabus comprised a compulsory paper covering a wide range of mathematics, with five unit tests. Three of these, covering mechanics, statistics and problem solving, were compulsory. Thus the AQA syllabus had a small (10 per cent weighting) compulsory element of mechanics.

The Curriculum 2000 changes meant that the syllabuses in 2004 were much more uniform. Candidates in the CCEA, Edexcel, OCR and WJEC syllabuses had to take P1, P2 and P3 and three other units. AQA's was a little different, retaining something of the flavour of the 1998 syllabus. These candidates had to take a compulsory mathematical methods paper, comprising a mixture of pure mathematics and statistics, as well as three further units of pure mathematics and two other units. In all syllabuses, the additional units were usually applications units. 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.[4] The units were equally weighted, and candidates had the opportunity to re-sit units.

Typically each unit was examined by a timed examination (1 hour and 30 minutes for the CCEA, Edexcel, WJEC examinations and 1 hour and 20 minutes for AQA and OCR). There were clear rules in place in question papers regarding the use of calculators. Most awarding bodies offered little or no coursework. The main exception was AQA, whose units in mechanics and statistics each included 30 per cent coursework.

Options

Examination papers in both 1998 and 2004 consisted wholly of compulsory questions. Choice therefore existed only at the level of permitted choice of units. The reviewers noted

[4] It was also possible to combine two AS units and four A2 units to make the A level.

that the choice of units was not usually a matter of choice for the individual students, with centres largely determining patterns of optional units.

The level of choice in 2004 was wider than in 1998. The reviewers noted that, while this might lead to greater numbers of candidates opting for the subject overall, the range of combinations of units they had taken would be greater, making it hard for end users to be confident about the content they had covered.

In 2004, the numbers of possible routes to AS and A level mathematics were as follows.

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

Question papers

In both years, the majority of the assessment for all awarding bodies was by timed examination. The small time differences between the awarding bodies in 2004 were not considered significant.

However, the total examination time for each qualification increased quite markedly from 1998 to 2004, broadly from 3 hours to 4.5 hours for AS and from 6 hours to 9 hours for A level. The greater examination time in 2004 meant that the syllabus material was covered more completely, and this represented increased demand. However, it also had the effect of reducing demand, in that the papers were rather more predictable in structure and in content than before. In 1998 some questions had covered more than one area of content, which reviewers judged to be particularly demanding. However, in 2004 all questions focused on a single topic area.

In 1998 all of the awarding bodies used some long, unstructured questions, and some of them used multi-staged questions. In 2004 the papers had become more accessible in linguistic terms. However, as a result, questions had become so structured as to become leading. The reviewers also noted that this resulted in little attempt being made to test the construction of rigorous arguments, as referred to in AO2.

Taking all factors into account, the reviewers considered the demand of question papers in 1998 to be marginally higher than in 2004.

Coursework

In 1998, none of the awarding bodies, with the exception of AQA, offered a coursework element. This remained largely the case in 2004. AQA gave 30 per cent weighting to coursework tasks set by the awarding body for the applications units in mechanics and in statistics. Edexcel also had low-weighted components in some of the statistics units. On the basis of the information available, the level of the coursework was judged about right.

Summary

- The changes associated with Curriculum 2000 led to a greater consistency across the awarding bodies in A level mathematics syllabuses. However, at the same time, each syllabus offered a greater variety of routes to A level mathematics. This helped to make mathematics more accessible.
- There has been a welcome change in the accessibility of question papers. However, the degree of structuring of questions that was referred to in the 1998 review has, if anything, increased.
- The increased examination time in 2004 has resulted in greater thoroughness and transparency, but it has also led to greater predictability in the structure and content of question papers.

6. Progression in GCSE and A level mathematics

GCSE to AS level

The nature of the assessment objectives changes from GCSE to A level. At GCSE they are essentially based on subject content. At A level they emphasise skills and attitudes.

In terms of algebraic manipulation, the higher-tier question papers suggest a clear route of progression to AS level. However, the performance review suggested that even candidates with good GCSE grades had mastered only some areas of the syllabus, making the transition difficult. Moreover, strong candidates at the intermediate tier would find the transition even more difficult, as some topics would not have been covered in sufficient depth and other topics not at all.

GCSE mathematics contains no mechanics, meaning that mechanics is new at AS level. However, the statistics content in GCSE offers more natural progression to AS level.

AS to A2 level

The assessment objectives and their weightings for AS and A2 levels are identical. In addition, the published performance descriptions of AS and A2 have only very minor differences, most of which reflect differences in content rather than performance. Taken together, this implies no obvious incline of difficulty from AS to A2. There is the opportunity for some less structured questions at A2, although these do not seem to be much in evidence, and the AS and A2 papers are very similar in style. However, there is a step up in syllabus content from AS. For this reason, marks are more difficult to obtain.

7. Standards of performance

GCSE

Materials available

The reviewers considered GCSE candidates’ work from all awarding bodies in 2004. In addition, performance in 2004 was evaluated against the performance descriptions generated by the 1999 study. Details of the materials used are provided in Appendix B.

Performance descriptions

The methodology used in this review was slightly different than that used in previous ones, as performance descriptions from the previous review of GCSE mathematics were available. The reviewers were therefore asked to compare key features of candidates’ performance in 2004 with the performance descriptions created in 1999. The description for each grade boundary was revised on the basis of these comparisons. This meant that it was possible to produce a clear picture of any changes between the two years in performance descriptions. In fact, the reviewers found that the 1999 performance descriptions were easily applicable to performance in 2004 and that only minor amendments were required. The 1999 performance descriptions can be found in Appendix D.

It should be noted that performance descriptions are particularly problematic for some grades in mathematics. Where candidates do not have to score well on a paper to achieve the grade, their mark can be achieved with good performance across only a limited group of tasks or with a lower performance across a wider range. This also had some relevance when judging attainment at neighbouring tiers at GCSE.

Description of performance at the GCSE grade A boundary

In **number**, the reviewers found that candidates were generally secure in:
- standard form
- calculations involving powers and roots (numerical)
- reverse percentage problems, and
- identifying upper and lower bounds of numbers.

There was some evidence of success in:
- the effects of rounding on calculations
- changing a recurring decimal to a fraction
- multiplying factors, and
- surd manipulation.

In **algebra**, the reviewers found that candidates were generally secure in:

- multiplication of two linear expressions
- finding common factors and factorising $x^2 + bx + c$
- simultaneous equations
- rearranging formulae (subject appearing once)
- manipulating algebraic expressions, eg $(3x^4 y^2) \times (x^2 y^3)$
- solving linear and quadratic inequalities
- representing inequalities graphically
- sketching linear, quadratic, cubic and reciprocal functions, and
- gradient and intercept of straight line.

There was some evidence of success in:

- factorising $ax^2 + bx + c$
- solving $ax^2 + bx + c = 0$ by factorising or by the formula
- forming and manipulating algebraic expressions and equations
- rules of indices for negative and fractional powers (algebraic)
- proportionality
- graphical solutions of equations
- linear and quadratic simultaneous equations
- perpendicularity of straight lines by gradient
- simple algebraic fractions
- numerical solution of equations by trial and improvement, and
- surds.

In **shape and space**, reviewers found that candidates were generally secure in:

- similar triangles
- volume of compound prisms
- multiple application of 2-D trigonometry or Pythagoras (unstructured), and
- dimensions to distinguish formulae.

There was some evidence of success in:

- interpretation of sin, cos and tan graphs
- 3-D trigonometry and Pythagoras
- congruent triangles
- sine and cosine rules
- lengths of arcs and areas of sectors
- volumes of cones and spheres and surface areas of cylinders
- similar shapes (areas and volumes)
- angles in circles

- enlargement with negative or fractional scale factor
- vectors
- bearings and back bearings, and
- geometric proof.

In **data handling**, the reviewers found that candidates were generally secure in:

- cumulative frequency graphs – drawing and interpreting, and
- tree diagrams for compound events or ‘AND and OR’ rules.

There was some evidence of success in:

- histograms – drawing and interpreting
- sampling
- conditional probability, and
- box plots.

Standards of performance at the GCSE grade A boundary

Standards of performance were slightly uneven across the awarding bodies, with WJEC candidates demonstrating the highest standard and OCR’s the lowest. WJEC candidates showed a greater range of knowledge and skills, often with strong algebra. They had greater mastery of more complex concepts, performing well on harder questions. The reviewers noted that OCR question papers were very demanding and that this appeared to affect the performance of candidates, who struggled on the harder questions.

Description of performance at the GCSE grade C boundary

In **number**, reviewers found that candidates were generally secure in:

- using whole numbers to make estimates
- simple fraction, percentage, decimal equivalence
- calculating the result of percentage or fractional change
- calculations with simple ratios in context
- solving problems with metric or imperial units, and
- simple speed calculations.

There was some evidence of success in:

- use of one significant figure in making estimates for multiplication and division
- correct use of calculator for numerical problems
- calculation with directed numbers
- expressing one number as a fraction or percentage of another
- equivalent fractions, decimals and percentages
- calculations using ratios

- repeated proportional change
- surds
- calculations with fractions, and
- LCM.

In **algebra**, the reviewers found that candidates were generally secure in:
- describing rule for *n*th term of a linear sequence
- solving simple equations (eg $x^2 = 20$) using trial and improvement
- forming simple algebraic expressions and equations
- solving simple linear equations, and
- drawing straight line graphs given algebraically.

There was some evidence of success in:
- describing the rule for *n*th term of a quadratic sequence
- solving simple cubic equations using trial and improvement
- forming and solving linear equations
- representing simple inequalities on a number line
- simple use of laws of indices (eg $a^2 \times a^3 = a^5$)
- drawing and using simple curves
- drawing regions to represent inequalities, and
- simultaneous equations.

In **shape and space**, the reviewers found that candidates were generally secure in:
- angles in parallel lines and in quadrilaterals
- bearings
- area or perimeter of compound rectilinear shape
- straightforward circumference and area of circle
- 2-D representation of 3-D
- enlargement by whole number scale factor from centre (0,0), and
- rotation about origin or reflection in y *or* $x = \pm c$.

There was some evidence of success in:
- Pythagoras' theorem
- trigonometry
- angles in polygons
- length and area calculations, including circle and trapezium
- volume of prism
- enlargement from non-origin centre or by fractional scale factor.
- rotation about non-origin or reflection in $y = \pm x$
- upper and lower bounds of measurements

- compound measures (speed and density)
- simple loci
- dimensions of formulae, and
- volume of cones and spheres.

In **data handling**, the reviewers found that candidates were generally secure in:

- plotting a scatter diagram
- commenting on correlation
- mean of discrete frequency distribution
- drawing grouped frequency diagram
- constructing pie chart
- surveys, observation sheets, questionnaires
- probability based on equally likely events, and
- $P(A') = 1 - P(A)$.

There was some evidence of success in:

- line of best fit
- calculating and using relative frequency
- mean of grouped frequency distribution
- comparing distributions using frequency diagrams, averages and spread
- identifying or avoiding bias in surveys, questionnaires, hypotheses
- box plots
- histograms, and
- tree diagrams.

Standards of performance at the GCSE grade C boundary

The reviewers commented that at the higher tier there was often limited evidence on which to base judgements about candidates' achievements, as only a small proportion of questions on higher-tier papers are targeted at grade C candidates.

Standards of performance at the higher tier were broadly similar across the awarding bodies, with the exception of Edexcel candidates, who demonstrated a lower standard of performance. Edexcel candidates were judged to be weaker in all areas, often attempting fewer questions, particularly on harder topics. Their coursework was also less well developed than that of candidates from other awarding bodies.

At the intermediate tier, standards of performance were similar across CCEA, Edexcel and WJEC. AQA candidates tended to demonstrate a higher standard of performance, while OCR candidates were judged to be weaker than those from the other awarding bodies. AQA candidates were competent over a wider range of topics than other candidates, often showing better algebra. Their mistakes tended to be slips rather than conceptual errors. The reviewers commented that the AQA question papers at both the intermediate and higher tiers were well structured, with a clear gradient of difficulty, which helped candidates to show what they knew, understood and could do.

The reviewers found that OCR candidates performed inconsistently across the question papers and showed little evidence of higher-level skills, such as use of indices, trigonometry, Pythagoras and trial and improvement. The reviewers commented that OCR question papers did not have clear gradients of difficulty and that a difficult question early in unit 6 had appeared to derail some candidates. The reviewers also questioned whether the level of demand was similar across unit papers, leading potentially to some easier routes through the syllabus.

Reviewers also compared performance at grade C across tiers within an awarding body. They found that overall performance was similar. However, they judged AQA candidates at the intermediate tier to be stronger than those at the higher tier. The reviewers commented that AQA intermediate-tier candidates were able to demonstrate what they knew, understood and could do across a range of questions. These findings should be seen in the context of the often sparse evidence available at the higher tier, where there was less evidence of candidates' achievement, as they had often answered only a few questions correctly and had usually made a realistic attempt at less than half of the question paper. The coursework of higher-tier candidates was sometimes better than that of intermediate-tier candidates and made a significant contribution to the final grade.

Many candidates at the higher tier seemed to attempt only the common tier questions, registering zero marks for all the other questions. This raises concerns about progression from GCSE grade C higher tier to AS level.

Description of performance at the GCSE grade F boundary

In **number**, the reviewers found that candidates were generally secure in:

- simple fractions and percentages of a whole
- addition and subtraction of decimals to two decimal places, and
- simple estimation.

There was some evidence of success in:

- using place value to **mu**ltiply and divide by 10, 100, 1000
- ordering, adding and subtracting directed numbers in context
- calculating fraction or percentage parts
- non-calculator multiplication and division of three-digit numbers by two-digit numbers
- use of estimation or inverse operations

- multiples and factors, squares
- calculations with fractions, and
- knowing that percentages are out of 100.

In **algebra**, the reviewers found that candidates were generally secure in:
- using simple formulae expressed in words
- co-ordinates in first quadrant, and
- finding the next term or diagram in a pattern.

There was some evidence of success in:
- number patterns – describing and using to find later terms
- forming and using simple formulae
- conversion graphs, and
- co-ordinates in four quadrants.

In **shape and space**, the reviewers found that candidates were generally secure in:
- drawing 2-D shapes in different orientation and identifying congruent shapes
- reflecting shapes in a mirror line
- finding order of rotational symmetry
- reading scales on measuring instruments
- finding perimeters, areas and volumes by counting
- the meaning of ‘parallel’ and ‘perpendicular’, and
- naming shapes.

There was some evidence of success in:
- constructing angles and using language
- identifying all symmetries of a shape
- converting metric units
- knowing rough metric and imperial equivalents and estimating everyday measures
- knowing the angles in a quadrilateral
- naming angles, and
- constructing a complete shape to have rotational symmetry.

In **data handling**, the reviewers found that candidates were generally secure in:
- collating discrete data in a frequency table, grouping where appropriate
- interpreting frequency diagrams (various) and line graphs
- drawing frequency diagrams (various)
- mode and median, and
- simple vocabulary of probability, eg ‘fair’, ‘certain’ and ‘likely’.

There was some evidence of success in:

- mean of discrete data
- comparing two distributions
- interpreting pie charts and other diagrams
- using probability scale 0 to 1
- making subjective estimates of probability
- probability based on equally likely outcomes and experiments, and
- drawing and interpreting pictograms.

Standards of performance at the GCSE grade F boundary

Standards of performance were judged to be broadly comparable across the awarding bodies at this grade boundary, with the exception of AQA candidates, who were judged to be slightly better. The reviewers commented that AQA question papers were very accessible, giving candidates plenty of opportunity to demonstrate their knowledge, understanding and skills and therefore to be rewarded for positive achievement.

Summary of GCSE performance

The performance descriptions from 1999 were found to apply with a high degree of consistency to candidates' work from 2004. This enabled reviewers to be confident that standards had been maintained over the period.

Overall there was some variation in standards of performance at each key grade boundary. WJEC candidates performed best at grade A. AQA candidates tended to demonstrate a higher standard of performance at grades C (intermediate tier) and F. Reviewers judged OCR candidates to be weaker at grades A and C (intermediate tier). Performance across tiers was found to be broadly comparable, with some variations within awarding bodies. In several cases, these differences were attributed to the extent to which question papers enabled candidates to demonstrate their knowledge and understanding.

There was some evidence that the grade C achievement at the higher tier would present candidates with a difficult transition to AS level study.

A level

Materials available

The reviewers considered AS and A2 candidates' work in 2004 from each awarding body at the grade A and grade E boundaries, although no work was available from AQA at A2 grade E. The reviewers also considered 1998 A level candidates' work from AQA, Edexcel and WJEC. Details of the materials used are provided in Appendix B.

OCR candidates at A2 grade E were some way below the grade boundary in 2004, and this had an impact on findings.

Performance descriptions

The reviewers were asked to identify key features candidates' performance in 2004 against each of the following assessment objectives.

- *Assessment objective 1* – Recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of contexts.

- *Assessment objective 2* – 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.

- *Assessment objective 3* – Recall, select and use their 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.

- *Assessment objective 4* – 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.

- *Assessment objective 5* – 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.

For this review the reviewers' findings were summarised for each assessment objective at grades A and E at both AS and A2 in terms of:

- evidence that candidates were generally secure in meeting all or part of the assessment objective, and
- evidence either that candidates were failing to meet the assessment objective or that the papers were not providing an opportunity for candidates to meet the assessment objective.

The reviewers commented repeatedly on how the structure and content of the 2004 AS and A2 examination papers had failed to provide candidates with an opportunity to demonstrate their knowledge, skills and understanding against the assessment objectives. Four key issues emerged:

- There were very few opportunities in any of the papers for candidates to construct extended arguments for handling substantial problems presented in unstructured form (AO2). With the exception of some mechanics questions, all the papers comprised highly structured questions that did not allow for extended arguments.

- Although candidates were required to recall and use their knowledge of mathematical models in the applications units (AO3), there was little opportunity to select a model, as these were either provided or prompted for in the question, and there were very few opportunities for discussion of the assumptions made or for refinement of such models.

- There was some use of realistic contexts (AO4) in applications units, and of using the results of calculations to make predictions, but there were very few opportunities for candidates to comment on the context and read critically and comprehend longer mathematical arguments or examples of applications. Pure papers were almost entirely context-free, although it was noted that in one pure paper an attempt was made to use differential equations to relate mathematics to real-world contexts.

- Although the papers provided plenty of opportunity for candidates to demonstrate their competence in using a calculator (AO5), the requirement to give answers to appropriate accuracy was often compromised by rubrics asking for answers to three significant figures. Candidates' understanding of the limitations of such technology and when not to use it was rarely tested.

Description of performance at the AS level grade A boundary

For 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.

For AO2, in so far as it was tested, 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.

For AO3, in so far as it was tested, 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).

For AO4, in so far as it was tested, 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).

For 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.

Standards of performance at the AS level grade A boundary

Performance was judged to be broadly comparable across the awarding bodies at this grade boundary.

Description of performance at the AS level grade E boundary

For AO1, the reviewers found evidence that candidates were generally secure in:
- straight-line co-ordinate geometry.

There was some evidence of success in:
- simple algebra and trigonometry
- the binomial theorem
- indices and logs
- integration and differentiation
- plotting of graphs

- calculus, and
- number concepts.

For AO2, in so far as it was tested, 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
- reproducing standard proofs.

For AO3, in so far as it was tested, the reviewers found that there was some evidence of success in:
- modelling (in the application units).

For AO4, in so far as it was tested, the reviewers found that there was some evidence of success in:
- the use of the results of calculations to make predictions, and
- understanding applications.

For 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.

Standards of performance at the AS level grade E boundary

There was some variation in standards of performance at this grade boundary in 2004. The reviewers judged the performance of CCEA and Edexcel candidates to be slightly stronger overall, while OCR and WJEC candidates performed less well.

The reviewers commented in particular on the low level of attainment in the OCR statistics papers, where candidates demonstrated knowledge that was more appropriate to the GCSE higher tier.

Description of performance at the A level grade A boundary

For 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).

For AO2, in so far as it was tested, 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.

For AO3, in so far as it was tested, the reviewers found evidence that candidates were generally secure in:

- their ability to construct accurate models (particularly in the applications units), and
- 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.

For AO4, in so far as it was tested, the reviewers found evidence that candidates were generally secure in:

- comprehending translations of common realistic contexts into mathematics (in the applications units), and
- reflecting on results (in the applications units).

There was some evidence of success in:

- making predictions and commenting on the context.

For AO5, the reviewers found evidence that candidates were generally secure in:

- using calculators and other resources accurately and efficiently
- appreciating whether an answer was sensible or plausible, and
- appropriate rounding.

Standards of performance at the A level grade A boundary

In 2004, standards of performance across AQA, CCEA and WJEC were broadly comparable at this grade boundary. Edexcel candidates demonstrated a higher standard of performance, while OCR candidates were judged to be weaker than those from other awarding bodies.

Edexcel candidates demonstrated a consistently high level of knowledge and understanding across the range of pure mathematics and mechanics papers. The reviewers commented that the Edexcel question papers gave candidates plenty of opportunity to demonstrate what they knew, understood and could do.

OCR candidates performed poorly on mechanics and, in particular, on pure papers, showing evidence of significant gaps in their knowledge. For example, they were weak on calculus in P3 and on power and moments in M2.

Description of performance at the A level grade E boundary

For 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
- the ability to apply techniques in a variety of contexts, and
- the ability to determine which facts/skills were required.

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

For AO3, the reviewers found evidence that candidates were generally secure in:
- recalling, selecting and using simple standard mathematical models, and
- quoting learned assumptions about given models.

There was some evidence of success in:
- the ability to interpret results and discuss assumptions and refinements.

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

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

Standards of performance at the A level grade E boundary

Standards of performance were rather uneven at this grade boundary in 2004. CCEA and in particular Edexcel candidates showed a higher level of performance, while WJEC and especially OCR candidates were found to be weaker. In the case of OCR, this was partly because the candidates supplied were some way below the grade boundary. It is therefore impossible to draw any conclusions about relative standards between OCR and other awarding bodies. However, that the reviewers were able to identify a lower standard of work among the OCR candidates suggests that the procedure used is effective, while the nature of the weaknesses identified casts some useful light on the way that candidates' performance varies at this grade.

CCEA candidates demonstrated sustained performance across the range of pure, mechanics and statistics papers. Edexcel candidates showed a broad range of knowledge and consistent performance across units. The reviewers commented that the question papers were well constructed and accessible to the full range of ability, giving candidates plenty of opportunity to demonstrate their knowledge and understanding at this level.

Although WJEC candidates tended to perform reasonably well in mechanics papers, their performance in pure papers was often weaker than that of candidates from other awarding bodies, and they often attempted just a few questions.

OCR candidates demonstrated uneven performance across units, with much weaker performance in pure papers than in mechanics. The reviewers commented that candidates had attempted very few questions in the pure papers and were able to demonstrate only very basic knowledge. For example, there was no evidence of knowledge of partial fractions in P3.

Standards of performance over time at A level: grade A

At grade A the reviewers found that overall standards of performance had been maintained from 1998 to 2004 across the three awarding bodies for whom work was available in both years. However, Edexcel candidates were judged to be slightly better in 2004, demonstrating more consistent performance across the range of pure and mechanics papers.

Standards of performance over time at A level: grade E

At grade E reviewers found that standards had broadly been maintained between 1998 and 2004 across the three awarding bodies for whom 1998 work was available.

Summary of A level performance

- At AS grade A there were no differences in standards between the awarding bodies in 2004. In the other comparisons made, some awarding bodies were found to be out of line, as follows.

- Edexcel candidates were judged to be better at both grades A and E at A2. This trend was quite marked at both grade boundaries.

- WJEC candidates were found to be weaker at grade E at AS and especially A2 level.

- OCR candidates were judged to be much weaker than those from other awarding bodies at A2 grades A and E. At A2 grade E, OCR candidates were found to demonstrate a lower standard of performance in every comparison. However, it is difficult to draw conclusions about the significance of these findings, as all the candidates were some way below the grade E boundary.

- The reviewers found that overall between 1998 and 2004 standards of performance had been maintained.

Appendix A: Syllabuses reviewed

GCSE syllabuses reviewed

Year	Awarding body and syllabus				
	AQA	**CCEA**	**Edexcel**	**OCR**	**WJEC**
1999	2500	G60–61	1385	1662	018401–03
2004	3301	G60–61	1387	1966	018401–03

A level syllabuses reviewed

Year	Awarding body and syllabus				
	AQA	**CCEA**	**Edexcel**	**OCR**	**WJEC**
1998	4136	A61	9371–9396		2399
2004	6301	A2210	8450/9450	3840/7840	7790

Appendix B: Scripts reviewed

Numbers of awarding bodies' GCSE scripts reviewed

Grade	AQA		CCEA		Edexcel		OCR		WJEC	
	1999	2004	1999	2004	1999	2004	1999	2004	1999	2004
A		10		10		10		10		10
C(H)*		10		10		10		10		10
C(I)*		10		10		10		10		10
F		10		10		10		10		10

* H = higher tier; I = intermediate tier.

Note: No GCSE scripts from 1999 were used in the current review. The scripts had been reviewed in 1999 and performance descriptions derived from them (see Appendix D). These performance descriptions, updated to reflect the performance seen in the 2004 papers, form the basis of the 2005 GCSE performance descriptions given in Section 7.

Numbers of awarding bodies' A level scripts reviewed

Level and grade	AQA		CCEA		Edexcel		OCR		WJEC	
	1998	2004	1998	2004	1998	2004	1998	2004	1998	2004
AS:										
A		10		10	10	10		10		10
E		10		10	10	10		10		10
A2:										
A	10	10		10	10	10		10	10	10
E	10			10	10	10		10	10	10

Appendix C: List of reviewers

Coordinator	Frank Berkshire
Syllabus reviewers	Claire Baldwin
	Susan Barker
	Jonathan Longstaffe
	Sheila Messer
	Anthony Mitchell
	Patricia Morton
	Kevin Wallis
Script reviewers	Graham Ambridge
	Jean Duffitt
	Joanna Hauge
	Steve Humble (The Institute of mathematics and its Applications, IMA)
	Susan Jameson (Edexcel)
	Lorna Jones
	Jayne Kranat
	Samantha Ladner (The Association of Teachers of mathematics, ATM)
	John Ling
	Nick Lord (The Mathematical Association)
	Sara Neill (CCEA)
	Andrew Rogers
	Trevor Senior (AQA)
	Neil Sheldon (OCR)
	Rob Summerson
	Richard Thomas (WJEC)

Note: where participants were nominated by a particular organisation, the awarding body is shown in brackets after their name.

Appendix D: 1999 performance descriptions

Standards expected at grade C

Number

Generally secure in:	Use whole numbers to make estimates
	Simple fraction, percentage, decimal equivalence
	Calculate result of percentage or fractional change
	Calculate with simple ratios in context
	Solve problems with metric or imperial units
	Simple speed calculations
Some evidence of:	Use of one significant figure in making estimates for multiplication and division
	Correct use of calculator for numerical problems
	Calculate with directed numbers
	Express one number as a fraction or percentage of another
	Equivalent fractions, decimals and percentages
	Calculate using ratios
	Repeated proportional change

Algebra

Generally secure in:	Describe rule for *n*th term of a linear sequence
	Solve simple equations (eg $x^2 = 20$) using trial and improvement
	Form simple algebraic expressions and equations
	Solve simple linear equations
	Draw straight line graphs given algebraically
Some evidence of:	Describe rule for *n*th term of a quadratic sequence
	Solve simple cubic equations using trial and improvement
	Form and solve linear equations
	Represent simple inequalities on a number line
	Simple use of laws of indices (eg $a^2 \times a^3 = a^5$)
	Draw and use simple curves

Shape and space

Generally secure in:	Angles in parallel lines and in quadrilaterals
	Bearings
	Area or perimeter of compound rectilinear shape
	Straightforward circumference and area of circle
	2-D representation of 3-D
	Enlargement by whole number scale factor from centre (0,0)
	Rotation about origin or reflection in y or $x = \pm c$
Some evidence of:	Pythagoras' theorem
	Trigonometry
	Angles in polygons
	Length and area calculations, including circle and trapezium
	Volume of prism
	Enlargement from non-origin centre or by fractional scale factor
	Rotation about non-origin or reflection in $y = \pm x$
	Upper and lower bounds of measurements
	Compound measures (speed and density)
	Simple loci

Data handling

Generally secure in:	Plotting a scatter diagram
	Comment on correlation
	Mean of discrete frequency distribution
	Draw grouped frequency diagram
	Construct pie chart
	Surveys, observation sheets, questionnaires
	Probability based on equally likely events
	$P(A') = 1 - P(A)$
Some evidence of:	Line of best fit
	Calculate and use relative frequency

Mean of grouped frequency distribution

Compare distributions using frequency diagrams, averages and spread

Identifying or avoiding bias in surveys, questionnaires, hypotheses

Standards expected at grade A

Number

Generally secure in:	Standard form
	Calculations involving powers and roots (numerical)
	Reverse percentage problems
	State upper and lower bounds of numbers
Some evidence of:	Rational and irrational numbers
	Effects of rounding on calculations

Algebra

Generally secure in:	Multiplication of two linear expressions
	Find common factors and factorise $x^2 + bx + c$
	Simultaneous equations
	Rearrange formulae (subject appearing once)
	Manipulate algebraic expressions eg. $(3x^4 y^2) \times (x^2 y^3)$
	Solve linear and simple quadratic inequalities
	Represent inequalities graphically
	Sketch linear, quadratic, cubic and reciprocal functions
	Gradient and intercept of straight line
Some evidence of:	Factorising $ax^2 + bx + c$
	Solve $ax^2 + bx + c = 0$ by factorising or by the formula
	Form and manipulate algebraic expressions and equations
	Rules of indices for negative and fractional powers (algebraic)
	Proportionality
	Graphical solutions of equations

Shape and space

Generally secure in: Similar triangles

Volume of compound prisms

Multiple application of 2-D trigonometry or Pythagoras (unstructured)

Dimensions to distinguish formulae

Some evidence of: Sin, cos and tan graphs

3-D trigonometry and Pythagoras

Congruent triangles

Sine and cosine rules

Lengths of arcs and areas of sectors

Volumes of cones, spheres and surface areas of cylinders

Similar shapes (areas and volumes)

Angles in circles

Data handling

Generally secure in: Cumulative frequency graphs – draw and interpret

Tree diagrams for compound events or ‘AND and OR’ rules

Some evidence of: Histograms – draw and interpret

Sampling

Conditional probability

Standards expected at grade F

Number

Generally secure in: Simple fractions and percentages of a whole

Addition and subtraction of decimals to two decimal places

Simple estimation

Some evidence of: Use place value to multiply and divide by 10, 100, 1000

Order, add, subtract directed numbers in context

Calculate fraction or percentage parts

	Non-calculator multiplication and division of three-digit numbers by two-digit numbers
	Use of estimation or inverse operations
	Multiples and factors, squares

Algebra

Generally secure in:	Use simple formulae expressed in words
	Co-ordinates in first quadrant
	Next term or diagram in a pattern
Some evidence of:	Number patterns – describe and use to find later terms
	Form and use simple formulae
	Conversion graphs
	Co-ordinates in four quadrants

Shape and space

Generally secure in:	Draw 2-D shapes in different orientation and identify congruent shapes
	Reflect shapes in a mirror line
	Find order of rotational symmetry
	Read scales on measuring instruments
	Find perimeters, areas and volumes by counting
	Know meaning of ‘parallel’ and ‘perpendicular’
	Name shapes
Some evidence of:	Construct angles and use language
	Identify all symmetries of a shape
	Convert metric units
	Know rough metric–imperial equivalents and estimate everyday measures

Data handling

Generally secure in:	Collate discrete data in a frequency table, grouping where appropriate
	Interpret frequency diagrams (various) and line graphs
	Draw frequency diagrams (various)
	Mode and median

	Simple vocabulary of probability, eg ‘fair’, ‘certain’ and ‘likely’
Some evidence of:	Mean of discrete data
	Compare two distributions
	Interpret pie charts and other diagrams
	Use probability scale 0 to 1
	Make subjective estimates of probability
	Probability based on equally likely outcomes and experiments