Review of standards in physics

GCSE 2002–2007
GCE 2001–2007

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Contents

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. In order 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 GCSE physics in 2002 and 2007, and GCE physics in 2001 and 2007.

Prior to this review, QCA conducted reviews of standards over time in GCSE and A level physics in 2003. The results were published in a report that is available on the Ofqual website, www.ofqual.gov.uk. The key issues identified by the reviews were considered as part of this work.

By reviewing GCSE and GCE A level syllabuses at the same time, this study also provided the opportunity to consider the issue of progression between GCSE and A level.

The GCSE syllabuses included in this review attracted over 90 per cent of the 60,000 candidates who took GCSE physics in 2007.

The A level syllabuses included in this review attracted about two thirds of the 27,000 candidates who took A level physics in 2007.

Examination demand in GCSE physics

GCSE physics syllabuses in 2002 and 2007 conformed to the 1995 and 2000 subject criteria for physics respectively. Many of the changes described in this report occurred with the revision of syllabuses for first examination in 2003.

Key issues identified in the previous review of standards in GCSE physics

The 2002 review identified the following key changes to GCSE physics between 1997 and 2002.

- There was a reduction from three tiers of entry to two.
- There were changes in the national curriculum, which in turn led to a revised physics core.
- The extension subject content, which GCSE physics students studied beyond that specified for science (double award), was updated.
- There were changes to the national criteria for science coursework at GCSE.

The 2002 review concluded that these changes had had little impact on the overall demand of the GCSE physics examination between 1997 and 2002.

Materials available

Reviewers considered the syllabus documents, examiners' reports and question papers with associated mark schemes from each of the awarding bodies in 2002 and 2007. Details of the syllabuses included in the review are given in Appendix A.

Assessment objectives

The assessment objectives in each year conformed to the relevant subject criteria and were identical across the awarding bodies. There were, however, several changes to the assessment objectives between 2002 and 2007.

Table 1 shows the assessment objectives and their weightings in 2002.

Table 1: Assessment objectives and weightings in 2002

Assessment objectives		**Weightings**
AO1	Candidates should: carry out experimental and investigative work in which they plan procedures, use precise and systematic ways of making measurements and observations, analyse and evaluate evidence, and relate this to scientific knowledge and understanding	25%
AO2	Candidates should: recall, understand, use and apply the knowledge of physics set out in the syllabus	60%
AO3	Candidates should: communicate physical observations, ideas and arguments using a range of scientific and technical vocabulary and appropriate scientific and mathematical conventions	7.5%
AO4	Candidates should: evaluate relevant information in physics and make informed judgements from it	7.5%

Table 2: Assessment objectives and their weightings in 2007.

	Assessment objectives	**Weightings**
A01 – Knowledge and understanding	Candidates should: • recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques • demonstrate understanding of the power and limitations of scientific ideas and factors affecting	50%

	how these ideas develop • draw on existing knowledge to show understanding of the benefits and drawbacks of applications of science • select, organise and present relevant information.	
A02 – Application of knowledge and understanding, analysis and evaluation	Candidates should: • describe, explain and interpret phenomena, effects and ideas in terms of scientific principles and concepts, presenting arguments and ideas clearly and logically • interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams and graphs • carry out relevant calculations • apply principles and concepts to unfamiliar situations, including those related to applications of science in a range of domestic, industrial and environmental contexts • evaluate scientific information and make informed judgements from it.	30%
A03 – Investigative skills	Candidates should: • devise and plan investigations, drawing on scientific knowledge and understanding in selecting appropriate strategies • demonstrate appropriate investigative methods, including safe and skilful practical techniques, obtaining data which are sufficient and of appropriate precision, recording these methodically • interpret data to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, whenever possible, in explaining their findings • evaluate data and methods.	20%

In 2002 there was a requirement to allocate 15 per cent of the total assessment to communication and evaluation. By 2007 any specific reference to the assessment of communication skills had been dropped and replaced with a requirement to assess a candidate's ability to 'select, organise and present relevant information'. Similarly, where there was a specific assessment objective for evaluation in 2002, by 2007 it had been subsumed into a broader objective, which also addressed the application of knowledge and understanding and analysis.

By 2007 the assessment of knowledge and understanding had been broadened to include the need to 'demonstrate understanding of the power and limitations of scientific ideas and factors affecting how these ideas develop'. Candidates were also expected to 'draw on existing knowledge to show understanding of the benefits and drawbacks of applications of science'. This addition would seem to increase demand by requiring candidates to generate more in the way of qualitative discussions.

However, in practice this increase in demand did not materialise because the questions based on this objective were often trivial and not linked to knowledge or understanding of physics principles.

There was a reduction in the weighting allocated to the assessment of practical skills through coursework from 25 per cent to 20 per cent of the total assessment. This had the effect of increasing overall demand slightly. However, reviewers agreed that the demand imposed by the assessment objectives was appropriate for GCSE physics and that the changes were not significant.

Syllabus content

All the syllabuses showed a significant reduction in the content covered between 2002 and 2007. In 2007 some topics had been removed from GCSE on the basis that these were part of the key stage 3 national curriculum for science. This sometimes meant that fundamental explanations of phenomena were not tested. For example, the principles of energy transfer by the processes of conduction and convection were not included, only a description of where insulation is used was tested. Reviewers judged that the removal of such material to the key stage 3 curriculum material resulted in the loss of topics which had often been tested by questions requiring explanation, particularly at higher tier. This change had the effect of reducing demand at higher tier.

Some topics that were exclusively aimed at higher tier candidates in 2002 were re-designated as common to both foundation and higher tier in 2007. For example, in the Edexcel syllabus, calculations of electrical costs, half-life calculations, diffraction and the wave explanation of refraction all moved from exclusively higher tier in 2002 to both tiers in 2007. Similar changes in the Assessment and Qualifications Alliance (OCR) syllabus meant that much of the space topic was now assessed at foundation tier, as well as at higher. As a result of these changes there were fewer differences between the content specified at higher and foundation tiers. These changes had the effect of increasing the demand at foundation tier by 2007.

In addition to these general changes there were variations between awarding bodies.

There were some minor changes to the content prescribed by the Assessment and Qualifications Alliance (AQA) syllabus between 2002 and 2007. In common with most of the other awarding bodies, some key stage 3 material was dropped, for example the concept of pressure as force/area and associated applications such as hydraulic brakes. Boyle's law, the use of a capacitor as a timing device and detailed consideration of the optics of the eye and the projector were also removed. The content that was added tended to be concerned with the social implications of technological applications, rather than physics concepts. For example, candidates

were required to discuss the advantages and drawbacks of CCTV, mobile phones and the internet. These may be interesting considerations, but they did not add to the candidates' knowledge and understanding of physics. Some material classified as higher tier material in 2002, for example stellar evolution and seismic waves, was reclassified as common to both tiers in 2007.

The Northern Ireland Council for Curriculum, Examinations and Assessment (CCEA) syllabus for 2002 was not available to reviewers, but the inclusion in the 2002 question papers of topics often seen at AS level, such as the equations of motion and resistivity, showed that the syllabus contained more mathematically demanding material than the other awarding bodies. Reviewers judged that the range of topics in 2007 was appropriate for GCSE. In contrast with other awarding bodies, some key stage 3 ideas, such as density and pressure, had been retained.

Edexcel was judged to have the most ambitious syllabus in terms of content in 2007. Units on communications and on particles had been added since 2002. These included some demanding concepts, such as quarks, thermionic emission and the acceleration of charged particles. Centripetal force was also treated in a quantitative fashion. Reviewers considered that the syllabus was rather too demanding at foundation tier, especially as Edexcel also introduced single tier module papers. While reviewers welcomed the inclusion of challenging concepts on these single tier papers, they were concerned that weaker foundation tier candidates were exposed to some very difficult questions.

The OCR syllabus reclassified some content which was exclusively higher tier material in 2002, for example the space topic, as common to both tiers in 2007. The OCR 2007 syllabus was different from the other awarding bodies, with candidates studying the core and choosing from two options containing the physics extension material. Extension A covered electronics and control, whereas extension B was more mathematical and included the gas equation, spring constant and the use of the oscilloscope.

In the Welsh Joint Education Committee (WJEC) syllabus the range of topics included in the syllabuses for 2002 and 2007 was broadly similar. In both cases reviewers judged that the breadth of coverage was appropriate for GCSE physics. However, there were small changes that tended to replace traditional physics topics with more modern material. Concepts such as upthrust, relative density, expansion and thermometry, Fleming's left-hand rule and basic kinetic theory of gases were removed. Work was added, some of which was linked to the Welsh key stage 4 curriculum, such as digital and analogue signals, optical fibres and the turning effect of forces. There were also some reductions in the mathematical demand placed on foundation tier candidates. For example, in 2002 foundation tier candidates were expected to be able to use the equation $R = V/I$ to find any of the variables, but in

2007 they were only required to use the defining equation, and were not required to change the subject of the formula.

The overall effect of these changes for all the awarding bodies was to increase demand at foundation tier in 2007 as compared to 2002, since foundation tier candidates were faced with material that had previously been classified as higher tier only.

Reviewers judged that changes to the syllabuses had reduced demand at the higher tier. In particular, this was due to a reduction in the quantity and depth of written explanations required of candidates. Some of this reduction could be attributed to the loss of material now classified as key stage 3, which often covered fundamental principles. In addition, the reclassification of material from higher to foundation had an impact on the kind of questions that could be set, as topics previously tested at higher tier could now be tested only by questions targeted at grade C and below.

Scheme of assessment

The major changes to the scheme of assessment between 2002 and 2007 were:

- a reduction in the weighting of the practical coursework component from 25 per cent to 20 per cent – this applied to all the awarding bodies, except for CCEA where the weighting remained at 25 per cent for the coursework component
- an increase in the popularity of modular routes.

In 2002 all of the syllabuses under consideration used externally marked written papers for 75 per cent of the assessment. The remaining 25 per cent of the assessment was for practical coursework. This coursework was internally set and marked and externally moderated. By 2007 the weighting of the coursework component had been reduced across all awarding bodies, except CCEA. In theory, this reduction would lead to an increase in the demand on candidates, since less credit was given for the same coursework tasks. However, in practice, reviewers found this was not the case, as discussed in the 'Coursework' section on page 14.

In 2002 the total examining time (excluding coursework) ranged from 2 hours (AQA, WJEC) to 2 hours 30 minutes (Edexcel, CCEA) at the foundation tier and from 2 hours 15minutes (AQA) to 3 hours 30 minutes (CCEA) at the higher tier.

By 2007 the times ranged from 2 hours (WJEC) to 3 hours 30 minutes (Edexcel) at foundation tier and from 2 hours 15 minutes (OCR) to 3 hours 30 minutes (CCEA, Edexcel) at higher tier.

The significant increase in examining time at Edexcel, and at AQA, was due to modular testing. In 2007 each of these awarding bodies allocated 30 per cent of the total assessment to multiple choice module tests. These module tests (3 × 30 minute tests at AQA and 6 × 20 minute tests at Edexcel) increased the total assessment time. However, the time allocated to written examination papers was reduced, so that there were fewer opportunities for candidates to write any extended prose or to carry out multi stage calculations. Where assessment was purely end-of-course assessment (OCR, CCEA and WJEC) the time spent on written examinations stayed the same, except for the higher tier at OCR where the time fell by 30 minutes to 2 hours 15 minutes.

The Edexcel syllabus had six modules in total, with multiple choice module tests on each module lasting 20 minutes. Module tests were available three times per year. Candidates also sat a terminal examination, divided into three sections. Each section lasted 30 minutes and covered two modules. The AQA modular scheme was slightly different. Candidates covered six modules in total, with three modules tested by multiple choice module tests, each lasting 30 minutes and the remaining three modules tested in the terminal examination. The AQA syllabus stated that the terminal exam would also assess aspects of content covered in the modules tests.

A consequence of modularity was some fragmentation of linked concepts. For example, in the Edexcel syllabus the topic of nuclear physics was dealt with in three separate modules: module 6: waves, atoms and space, as basic radioactivity; module 11: movement and change, where the concept of half-life was considered; and module 18: particles, which dealt with particle physics. (Modules were numbered 1–18 across the suite of Edexcel GCSE science syllabuses, with six modules, 5, 6, 11, 12, 17 and 18, covered in the physics syllabus.) As the module tests were short and focused on each module's content, it became difficult for awarding bodies to assess whether candidates had formed an overview of the topic.

Reviewers were concerned that these modular schemes reduced the need for candidates to recall a large amount of information from across the syllabus. Candidates also had the opportunity to resit each module test once. These factors taken together acted to reduce the demand imposed by the schemes of assessment for Edexcel and AQA in 2007.

Table 3 shows the schemes of assessment in 2002 and 2007 at foundation tier.

The codes for each type of assessment in the tables below are:

E = *externally set and marked*

I = *internally set and marked, and externally moderated*

W = *written exam*

C = *coursework*

M = *module test (objective questions of different types – electronically marked)*

SC1= *assessment of practical coursework.*

Table 3: Schemes of assessment at foundation tier in 2002 and 2007

Awarding body	2002			2007		
AQA	2h SC1 *Total exam time = 2h*	EW IC	75% 25%	1h 30m 3 x 30m SC1 *Total exam time = 3h*	EW EM≈ IC	50% 30% 20%
CCEA	1h 1h 30m SC1 *Total exam time = 2h30m*	EW EW IC	37.5% 37.5% 25%	1h 15m 1h 15m SC1 *Total exam time = 2h30m*	EW EW IC	37.5% 37.5% 25%
Edexcel	1h 30m 1h SC1 *Total exam time = 2h 30m*	EW EW IC	50% 25% 25%	1h 30m 6 x 20m SC1 *Total exam time = 3h 30m*	EW♦ EM≈ IC	50% 30% 20%
OCR	1h 30m 45m SC1 *Total exam time = 2h 15m*	EW EW IC	50% 25% 25%	1h 30m 45m SC1 *Total exam time = 2h 15m*	EW EW IC	53.3 % 26.7%(A/B)♣ 20%
WJEC	2h SC1 *Total exam time = 2h*	EW IC	75% 25%	2h SC1 *Total exam time = 2h*	EW IC	80% 20%

≈ Module tests which can be retaken
♦Three 30 minute sections each testing 2 modules, taken in one sitting
♣Candidates do either extension option A or B

Table 4: Schemes of assessment at higher tier in 2002 and 2007

Awarding body	2002			2007		
AQA	2h 15m SC1 *Total exam time = 2h15m*	EW IC	75% 25%	1h 30m 3 x 30m SC1 *Total exam time = 3h*	EW EM≈ IC	50% 30% 20%
CCEA	1h 45m 1h 45m SC1 *Total exam time = 3h30m*	EW EW IC	37.5% 37.5% 25%	1h 45m 1h 45m SC1 *Total exam time = 3h30m*	EW EW IC	37.5% 37.5% 25%
Edexcel	1h 30m 1h SC1 *Total exam time = 2h30m*	EW EW IC	50% 25% 25%	1h 30m 6 x 20m SC1 *Total exam time = 3h30m*	EW♦ EM≈ IC	50% 30% 20%
OCR	1h 45m 1h SC1 *Total exam time = 2h45m*	EW EW IC	50% 25% 25%	1h 30m 45m SC1 *Total exam time = 2h15m*	EW EW IC	53.3 % 26.7%(A/B) ♣ 20%
WJEC	2h 30m SC1 *Total exam time = 2h30m*	EW IC	75% 25%	2h 30m SC1 *Total exam time = 2h30m*	EW IC	80% 20%

Between 2002 and 2007 reviewers judged that there was an increasing tendency towards fragmented assessment. In the case of some awarding bodies, question papers were shorter, with shorter questions used in order to retain breadth of coverage and a smaller number of marks available per paper. In addition, changes in content meant that more challenging content that lent itself to questions requiring explanations had been removed and there were fewer questions requiring multistage calculations.

≈ Module tests that can be retaken

♦ Three 30 minute sections each testing two modules, taken in one sitting

♣Candidates do either extension option A or B

Options

In 2002 none of the syllabuses reviewed had optional routes. All papers and questions were compulsory.

By 2007 OCR had introduced a choice of two extension options: option A covered electronics and control, processing waves, and energy and forces, while option B covered computational physics, communication and energy transfers. Both options were appropriately challenging, although reviewers judged that the more mathematical approach of option B would be better preparation for A level physics.

There were no other optional papers or optional questions within papers.

Question papers

Reviewers found that the increase in modular testing between 2002 and 2007 had an impact on question papers, both module tests and the remaining terminal examinations. Module tests were shorter (either 30 or 20 minutes), with fewer marks available for the paper. These papers, particularly the multiple choice tests, were not as effective at assessing certain higher order skills, such as the ability to describe, explain or evaluate. The terminal examinations in modular schemes were also shorter and, in the case of Edexcel, very structured with no requirement for candidates to draw on knowledge from across the whole syllabus. The AQA terminal examination papers covered new work, as well as part of the content addressed by the module tests, although candidates did not have to draw on knowledge from across the whole syllabus.

Between 2002 and 2007 reviewers judged that the demand of the question papers decreased at the higher tier. This was due to a change in the nature of the questions, which became more structured and presented less challenging, multistage, calculations and fewer opportunities for extended prose. In addition, the reclassification of material from higher to foundation tier meant that topics that had previously been tested at higher tier could now be tested only by questions targeted at grade C or below. There was also a noticeable reduction in the need to write coherent explanations at the foundation tier, where multiple choice or single word answers became more common. However, this was balanced by the inclusion of more challenging material in 2007, so that the overall demand at foundation tier was similar to 2002.

The AQA papers from both years were well designed with good use of diagrams. In 2002 there was an emphasis on physical laws and principles. The large number of questions, requiring a mixture of controlled response and short answers, ensured a broad coverage of the syllabus content. In 2007 candidates took three 30-minute module tests as well as a terminal paper. The module tests used multiple-choice

items, which gave a good coverage of the syllabus content but there was obviously no requirement for any extended writing. There was also a comparatively low amount of quantitative work, especially at foundation tier. Reviewers judged that the question papers were appropriately demanding, but that the higher tier was slightly less challenging in 2007 than in 2002.

The CCEA papers from both years were well designed with a suitable incline of difficulty in both tiers. In 2002 the foundation tier paper had a mixture of controlled-response and short-answer questions. Candidates had to answer 40 questions in a one-hour paper, which reviewers considered overly demanding. For example, the final foundation tier question, aimed at grade C candidates, was one on resistivity, which required good problem solving and communication skills. However, sufficient earlier questions were accessible to lower attaining candidates. The higher tier paper also had appropriately challenging questions, for example an open response question on resistivity of a wire. In 2007 the controlled response format had been dropped, as had the open response question, so that the papers were composed entirely of structured questions. There were still some challenging questions, where candidates were faced with problems set in context, for example one based on a hovercraft and one on a diving hawk. Overall the demand was similar in both years at foundation tier. Reviewers found that the 2002 higher tier paper was of a slightly higher demand than the 2007 paper, mainly due to more complex numerical questions.

The Edexcel question papers from 2002 were well designed and of appropriate demand. The higher tier paper contained some challenging calculations, for example one on the binding energy per nucleon which would not have looked out of place on an AS paper. The 2007 syllabus was examined by a mixture of controlled response module tests and three short, structured papers. The module tests were single tier, which meant that more able candidates were faced with several comparatively straightforward questions at the start of the paper. Conversely there were some higher demand questions which were not accessible to foundation tier candidates.

In 2002 the written papers allowed 1 mark per minute, which was reasonable. However, in 2007 the controlled response papers allowed only 50 seconds per question. Reviewers judged that this was not enough time for candidates to read the question and to give a considered response. It was disappointing to note that on one paper the grade F boundary was set at 6/24, the mark obtainable by chance. The terminal paper was divided into three 30-minute sections, which reviewers also judged to be too short to allow for answers which required any extended explanation or calculations.

Reviewers considered that the overall effect of these changes was to increase demand at the foundation tier, but to decrease demand at the higher tier.

The OCR papers were of an appropriate standard in both years reviewed. The examination questions, particularly at higher tier, required an accurate and detailed understanding of the syllabus content. The foundation papers in both years involved appropriate calculations and assessment of graphical skills. Higher tier papers had more demanding calculations and often set problems in novel contexts. In 2007 the extension material was presented in two optional papers. Both were of an appropriate standard, although reviewers judged that option B was slightly more demanding mathematically.

Reviewers considered that the WJEC foundation tier papers were equally demanding in 2002 and 2007, but that the demand at the higher tier fell slightly in 2007. This was mainly due to the fact that there were several high-demand numerical questions on the 2002 paper, for example a question about the number of electrons that pass through a lamp each minute, and another demanding question set in the context of a pile-driver. There were no questions of equivalent demand in 2007. In both years the question papers were well designed and the clear layout made them accessible for candidates. All the papers allowed a time of one minute per mark. The higher tier paper, at 2 hours 30 minutes, was the longest written paper offered by any of the awarding bodies and was considered to be relatively demanding in this respect.

Taking into account all the variations between the awarding bodies described above, reviewers judged that there was a general decrease in overall demand at the higher tier between 2002 and 2007. This was attributed mainly to the increased use of questions requiring shorter responses, fewer questions requiring extended written responses, lower mathematical requirements with fewer multistage calculations, increased use of controlled response questions and to increased structure within questions. Overall demand at foundation tier was little changed.

Tiering

There were no changes to the tiering arrangements, except at Edexcel where single tier module tests were introduced by 2007. This is discussed in 'Question papers' section above (page 12).

Coursework

The major change to the assessment of coursework was the reduction of the overall weighting from 25 per cent in 2002 to 20 per cent in 2007, for all awarding bodies except CCEA.

The coursework requirements were broadly the same in both years. Candidates were assessed on their ability to plan a scientific investigation and then to obtain, analyse

and evaluate the evidence. The assessment criteria for planning eased slightly in 2007, so that lower attaining candidates were not required to make a prediction of the outcome of the investigation. The criteria on obtaining evidence were broadened to require that candidates should use ICT for data-logging, although in practice candidates did not need to use ICT to gain full credit.

In 2002 a candidate's marks for the four skill areas had to be drawn from at least two pieces of work. It was possible for centres to submit the best mark achieved for each skill. These marks may each have been obtained on four different occasions, provided that at least one of the marks was drawn from the assessment of a practically based whole investigation. In 2007 a candidate's marks for the four skill areas had to be drawn from not more than two pieces of work. This constraint made it more difficult for candidates to achieve high marks, since they had to demonstrate different skills in the same piece of work.

Theoretically, these changes in the assessment and weighting of coursework between 2002 and 2007 should have led to an increase in the demand on candidates. However, reviewers judged that this increase in demand did not materialise in practice because of the predictable and formulaic way in which investigations were actually carried out. Evidence from the script review suggested that many candidates presented work for assessment based on the same problem, an investigation into the factors affecting the electrical resistance of a wire.

Summary

Reviewers judged that syllabus content was more demanding at foundation tier in 2007 because it included topics covered previously only at higher tier. However, this was balanced by an increase in questions requiring shorter answers. Reviewers concluded that the overall demands of the GCSE physics examinations at foundation tier had not changed between 2002 and 2007. In both years the demands were considered appropriate.

Reviewers considered that there was a slight reduction in demand at higher tier. This change was evident in the examinations offered by all of the awarding bodies. The main factors contributing to this change were:

- a reduction in the range of topics covered by the syllabuses, with the loss of some challenging concepts and transfer to the key stage 3 curriculum of some material covering fundamental ideas, which lent themselves well to questions requiring explanations
- for some awarding bodies, a reduction in the number of questions that required either longer written answers or calculations that involved several steps. This

was partly due to more multiple-choice questions and partly to the prevalence of shorter, more highly structured questions

- a general reduction in the mathematical demands made of candidates
- the increase in popularity of modular schemes, in which shorter tests based on a limited amount of content were taken by candidates. The facility to resit these tests was also a factor.

Standards of performance at GCSE

Reviewers considered candidates' work from all the awarding bodies in 2002 and 2007. The review included candidates' work from AQA's modular and linear syllabuses. No work was available from CCEA at GCSE grade F in 2007 as there were no candidates at this grade boundary. For modular syllabuses, AQA (modular) and Edexcel, reviewers saw candidates' work from the terminal examinations, but not from multiple-choice modular tests, although they were aware of how candidates had performed in these components. Further details of the materials used are provided in Appendix B.

Reviewers were asked to identify key features of candidate performance in 2007, based on the work seen at each of the key grades. Performance descriptors for each grade boundary were drawn up, focusing on the assessment objectives, as well as allowing for additional features of performance.

GCSE grade A performance descriptor

AO1: Knowledge and understanding

Candidates at this level:

- were able to recognise formulae and scientific terms and recall formulae and use scientific terminology correctly
- were able to show knowledge and understanding of some abstract concepts, such as interference of waves and ideas about the origins of the solar system
- were able to demonstrate understanding of the benefits and drawbacks of applications of science, such as the use of closed-circuit television
- were generally able to select, organise and present information.

However, reviewers were concerned about some aspects of the performance in 2007. For example, some abstract concepts, such as electromagnetic induction, were poorly understood. Candidates were able to recall a limited range of formulae and there was also very little evidence that candidates at this level were able to demonstrate an understanding of the power and limitations of scientific ideas. It should be noted, however, that the question papers very rarely gave them the opportunity to do this.

AO2: Application of knowledge and understanding, analysis and evaluation

Candidates at this level:

- were able to describe phenomena, such as the propagation of earthquake waves, in terms of scientific principles and concepts
- were able to interpret data and translate it from one form to another, extracting data from graphs and using it to calculate such quantities as acceleration from velocity-time graphs
- could sometimes manipulate equations to change the subject to the quantity required.

Reviewers were concerned that candidates at this level found it difficult to explain phenomena, and to apply principles and concepts to unfamiliar situations. They also had difficulty evaluating scientific information and making informed judgements from it, for example in deciding the best isotope to be used as a tracer in medicine, given the properties of a range of radioactive isotopes.

AO3: Investigative skills

Candidates at this level were able to:

- use their scientific knowledge to plan investigations
- make some use of preliminary investigations to determine the range of measurements which should be taken
- make a suitable range of measurements
- present data in a clear and methodical manner in tables and as graphs
- identify anomalous results
- draw conclusions consistent with the evidence
- make a simple analysis of the outcome of their investigation.

Reviewers were concerned that candidates' evaluation of data and methods was generally of a simplistic nature and that they showed little understanding of an appropriate degree of precision or of safe methods, other than repeating a standard range of precautions. There was also concern that they were unable to use their scientific knowledge as a basis for planning suitable investigative strategies, relying instead on their knowledge of standard physics experimental techniques. They had difficulty suggesting specific reasons for anomalous results and rarely referred their conclusions back to the initial scientific knowledge used to plan the investigation or attempted to express any relationship found in a quantitative manner.

Performance at GCSE grade A over time

With the exception of CCEA, there was a decline in the standards of performance at grade A between 2002 and 2007. This was less marked for AQA (linear) and for WJEC.

Candidates in 2002 showed more precise and detailed knowledge and understanding and were more consistent across the range of topics. They often performed better on calculations and gave better explanations. Reviewers commented that the Edexcel and OCR 2002 question papers gave candidates more opportunities to demonstrate higher-level concepts and skills. Reviewers noted that the AQA and Edexcel modular schemes had shorter terminal question papers and so there was less evidence of candidates' performance in 2007. Interestingly, OCR was the only linear scheme that reduced its examination time at higher tier between 2002 and 2007.

Performance at the GCSE grade A boundary across the awarding bodies in 2007

Standards of performance were broadly comparable across the awarding bodies in 2007, with the exception of CCEA and Edexcel. CCEA candidates were judged to be stronger, while Edexcel candidates were found to be weaker than those from other awarding bodies.

CCEA candidates demonstrated better knowledge and understanding across a wider range of topics. They were able to give accurate and coherent explanations and their answers had a high proportion of correct calculations. Reviewers commented that CCEA question papers gave candidates the opportunity to show higher order skills.

As Edexcel was a modular scheme in 2007, reviewers were only able to review candidates’ performance in the terminal examination and not in the controlled response modular tests. On the evidence available, reviewers found that Edexcel candidates had gaps in their knowledge and understanding of basic principles and their responses showed less convincing control of technical language. They also demonstrated weaker practical understanding. Reviewers commented that Edexcel question papers were less demanding and also gave candidates limited opportunity to show their knowledge, understanding and skills. This was also reflected in the syllabus review findings.

GCSE grade C performance descriptor

AO1: Knowledge and understanding

Candidates at this level were able to:

- recognise specific scientific facts from across the syllabus, using some scientific terminology and recalling simple principles, such as using the term ‘terminal velocity’ correctly
- describe simple practical techniques
- describe the benefits and drawbacks of applications of science, such as the use of CCTV or mobile phones
- select relevant information from text, tables or graphs and organise and present straightforward information.

Reviewers noted that the question papers very rarely gave candidates the opportunity to demonstrate understanding of the power and limitations of scientific ideas and factors affecting how these ideas develop. They were concerned that candidates showed limited understanding of important concepts. For example, few candidates could explain why an object falling under gravity in the earth's atmosphere reaches a terminal velocity. While candidates could describe simple practical techniques, they often omitted important experimental details. Reviewers were also concerned that candidates’ explanations of benefits and drawbacks of applications of science were seldom linked to understanding of scientific principles.

AO2: Application of knowledge and understanding, analysis and evaluation

Candidates at this level were able to:

- describe some simple physical phenomena, such as electrostatic attraction
- interpret data when presented in tables, graphs or prose; they could construct graphs or tables and translate data from one form to another and could use diagrams, such as simple circuit diagrams or optical ray diagrams, to describe and explain phenomena
- substitute numerical values into scientific formulae to calculate quantities such as speed, or work done
- apply their knowledge to familiar simple situations
- make simple judgements based on scientific information, for example choosing the most cost-effective insulation for a house.

However, reviewers were concerned that candidates often found it difficult to present a logical argument that involved several steps, or to write a relevant explanation, such as how electrostatic attraction was used in a photocopier. Reviewers were concerned to see that candidates could rarely rearrange formulae to change the

subject of an equation. Candidates also struggled to apply their knowledge to unfamiliar contexts.

AO3: Investigative skills

Candidates at this level were able to:

- plan simple investigations, identifying some of the relevant variables - they could control appropriate variables and had understood the main principles of what constituted a 'fair test'
- take a number of measurements
- show standard experimental precautions to ensure safety and reliability, for example, wear goggles and repeat the reading three times
- organise their tables into tables and graphs and choose an appropriate scale for graphs
- identify anomalous results
- draw conclusions consistent with their observations.

Reviewers were concerned that candidates did not always use appropriate scientific knowledge and understanding to justify their actions in carrying out investigations. They showed limited understanding of a suitable range or of an appropriate degree of precision. For example, candidates did not always use an appropriate number of significant figures, and units were sometimes omitted. They often struggled to construct a realistic best-fit line and they also rarely suggested any reasons for identifying anomalous results. Conclusions tended to be simple and not quantitative, the notion of proportionality was not always well understood, and the term 'correlation' was often used incorrectly. There was limited evidence of any evaluation of the results or of the experimental method used.

Performance at GCSE grade C over time

Overall, with the exception of WJEC, there was a decline in the standards of performance at grade C higher tier between 2002 and 2007. This was very marked for AQA (linear), Edexcel and OCR. Candidates in 2002 demonstrated better knowledge and understanding across more of the syllabus content and, in particular, of more difficult topics. They were often better at calculations and explanations. Candidates in 2002 gave better answers than their 2007 counterparts to similar questions. Reviewers commented that 2007 candidates showed superficial

understanding and were also given credit on occasions for non-physics material in their answers.

Reviewers commented that the AQA and OCR question papers were more challenging in 2002. This reflected the findings of the syllabus review. As at grade A, reviewers noted that candidates were producing less evidence of attainment in 2007, partly due to the shorter terminal examinations in the modular schemes and that this may also have had an impact on their judgements.

At foundation tier, with the exception of CCEA, there was a decline in the standards of performance between 2002 and 2007. This was especially marked for OCR and WJEC, where candidates from 2002 were judged to be stronger on every occasion. Candidates in 2002 were judged to be more consistent in their responses and to perform better than their 2007 counterparts on similar questions. In the case of WJEC, reviewers judged that candidates' coursework in 2002 was better, with more detailed plans and analysis. The nature of the practical tasks in the 2002 coursework seen was more demanding and produced more evidence of investigative skills (AO3).

Performance at GCSE grade C boundary across the awarding bodies in 2007

At higher tier the performance of candidates was comparable between AQA and OCR. CCEA candidates and, to a lesser extent, WJEC candidates were judged to be stronger, while Edexcel candidates were found to be weaker.

CCEA candidates demonstrated a wider range of knowledge and skills and their coursework was often better. WJEC candidates also showed better knowledge and understanding and they performed more consistently across the range of topics tested. By contrast, the answers of Edexcel candidates had many gaps and errors, showing inconsistent knowledge and understanding across the range of topics. Reviewers commented that their responses contained little evidence of work matching the grade C descriptor. As at grade A, they noted that the Edexcel question papers gave candidates limited opportunities to demonstrate their knowledge, skills and understanding.

At foundation tier, the performance of AQA (modular) and OCR candidates was comparable. AQA (linear) and CCEA candidates demonstrated a higher standard of performance, while Edexcel and WJEC candidates were judged to be weaker.

AQA (linear) candidates demonstrated better calculations and more consistent knowledge across a range of topics, performing well on more difficult topic areas as well as the more straightforward ones. CCEA candidates showed broader and more sophisticated knowledge. They showed more evidence of application of knowledge

and understanding, analysis and evaluation (AO2), and their coursework was often better than that of candidates from other awarding bodies.

By contrast, Edexcel candidates demonstrated superficial knowledge and weaker calculations. Their coursework planning and analysis were also weaker. Reviewers commented that the Edexcel question papers were insufficiently challenging and that credit was given to candidates for non-physics material in their answers. The performance of WJEC candidates was inconsistent and their coursework was often weaker.

Comparison across tiers in 2007

Standards of performance across foundation and higher tier at grade C varied by awarding body. In some cases, higher tier candidates were judged to demonstrate a higher standard of performance for their grade C. This was particularly marked for CCEA and, as might be expected from the comparison above, for WJEC (in the performance at GCSE grade C boundary across the awarding bodies in 2007). By contrast, Edexcel foundation tier candidates were found to be stronger than their higher tier counterparts.

GCSE grade F performance descriptor

AO1: Knowledge and understanding

Candidates at this level could normally:

- understand the simple terminology used in foundation tier questions and could complete sentences, either by selecting the correct term from a list of alternatives or by linking items from two short lists
- recall simple equations, such as speed = distance/time, and simple facts, for example that a comet moves around the sun
- recall circuit symbols, such as those for a cell or ammeter
- show an understanding of fundamental concepts, such as reflection, the repulsion of like charges, conductors and insulators, and environmental issues such as pollution
- show some understanding of the relative dates when inventions were made, for example that the telescope was invented before the internet
- give simple commonsense statements for and against nuclear power and other issues, such as the dangers involved and the need to avoid global warming.

Reviewers were concerned that candidates were unlikely to draw circuits containing ammeters and voltmeters with the correct connections. Their knowledge of fundamental key stage 3 concepts was often limited to a non-scientific, general knowledge level. They were unlikely to understand the factors affecting how ideas develop, and their arguments for and against nuclear power and other issues often did not involve scientific knowledge or understanding.

AO2: Application of knowledge and understanding, analysis and evaluation

Candidates at this level could normally:

- recall general explanations of familiar, concrete applications when asked in a simple and direct manner, for example they might recognise an advantage of using an electrostatic spray gun
- extract relevant data from a table and make simple deductions, where only one process was involved at any stage
- undertake basic calculations where the formula was provided in a simple form and where the data was immediately available, for example they could calculate speed from distance/time
- draw simple graphs where the points were located on major crossing points.

Reviewers were concerned that candidates were unlikely to explain logically the science behind an application. Candidates could not change the subject of a formula or convert from centimetres to metres. They also started calculations with numbers rather than a formula and often omitted the unit if it was not provided on an answer line. Instead of drawing lines of best fit, candidates often joined individual points with several straight lines.

AO3: Investigative skills

Candidates at this level could normally:

- produce a simple plan where a structured framework was in place for each element of their investigation
- show an awareness of the need for safety and for some form of fair test
- handle simple techniques well, such as measurements of length, meter readings and mass using a balance
- record and tabulate an adequate number of results in a simple format
- plot a sensible graph of the results, especially when provided with a scale

- improve on their presentation when ICT was used
- make a simple comment on the trend of their results
- suggest that the experiment might be improved with more repeats.

Reviewers were concerned that candidates rarely used scientific knowledge in establishing a plan for investigations. Candidates often provided measurements of length, meter readings and mass using a balance without giving units and without giving results to a consistent number of significant figures. Some points on graphs were not plotted by candidates accurately and a best-fit line was unlikely to have been drawn. Candidates at this level were not normally successful in using ICT to produce a suitable graph with sensible scales, labelled axes and a best-fit line. They were unlikely to understand the concept of proportionality or to explain the underlying science behind the trend of their results. Candidates also showed very limited evidence of evaluation.

Performance at GCSE grade F over time

No CCEA candidates were available at this grade boundary.

With the exception of WJEC, there was evidence of a decline in standards of performance at grade F between 2002 and 2007. This was especially marked for AQA, and in particular for their AQA (linear) syllabus. The 2002 AQA candidates demonstrated better knowledge and understanding and were more consistent. They were also stronger on application, analysis and evaluation (AO2).

Performance at GCSE grade F across the awarding bodies in 2007

There were no CCEA candidates available at this grade boundary.

Standards of performance across the AQA syllabuses and WJEC were broadly comparable. OCR candidates were judged to be stronger, while Edexcel candidates were found to be weaker. Reviewers commented that OCR candidates demonstrated better knowledge when answering on similar topics. By contrast, Edexcel candidates were often weaker on similar questions to those from other awarding bodies, showing weaker overall knowledge. Their responses had more gaps and they often made no attempt at calculations.

Summary

Between 2002 and 2007 there was an overall decline in the standards of performance at each grade boundary, although this was not the case for CCEA at grades A and C foundation tier and for WJEC at grade C higher tier and grade F. In some cases, the decline in the standards of performance was very marked.

Reviewers attributed this overall decline in part to the changes identified in the syllabus review. Question papers in 2007, particularly in the modular schemes, tended to be shorter. Questions were often very structured and there were fewer questions requiring explanations or extended written answers. Mathematical requirements were reduced with fewer multistage calculations. This meant that candidates were not asked to show knowledge, understanding and skills to the same extent as in 2002 and this was reflected in the evidence seen at the script review.

In 2007 there were variations in the standards of performance across the awarding bodies at each grade boundary.

CCEA candidates were found to demonstrate a higher standard of performance at each grade boundary, with the exception of grade F, where no CCEA candidates were available. By contrast, Edexcel candidates were judged to demonstrate a lower standard of performance at each grade boundary. Other awarding bodies were also found to be out of line at grades C and F. At grade C higher tier, WJEC candidates were found to be stronger. At grade C foundation tier AQA (linear) candidates were found to be stronger, while WJEC candidates were judged to be weaker. At grade F OCR candidates were judged to be stronger than candidates from the other awarding bodies.

Standards of performance across foundation and higher tier at grade C varied by awarding body.

At every grade boundary, reviewers commented on the very limited range of contexts that were used to assess candidates' investigative skills in 2007.

Examination demand in A level physics

The major issue that affected all A level examinations between 2001 and 2007 was the change in design of the A level qualification in line with the Curriculum 2000 reforms. This involved a move by all awarding bodies to unitised assessment based on a six-unit structure. The overall assessment of the A level qualification was split into the first half, Advanced Subsidiary (AS) and the second half, A2. The AS and A2 sections of the course were each assessed by three units and were equally weighted, 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.

(This leads to the slightly confusing situation that both qualifications were known as AS though deliberately different standards. Throughout this report, where AS refers to the 2001 qualification it means Advanced Supplementary and where it refers to the 2007 examination it means Advanced Subsidiary. For the purposes of clarification where this report is referring to Advanced supplementary the text is written in full and where the report is referring to Advanced Subsidiary it is abbreviated to AS.)

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

The most significant changes for A level physics between 2001 and 2007 were:

- the change to a mandatory six unit AS/A2 assessment structure as described above
- a move to less demanding AS unit assessments and more demanding A2 units
- a revised synoptic requirement.

A level syllabuses in 2001 incorporated the 1994 subject core for A level and Advanced Supplementary physics. Subject cores tended to deal with syllabus content but not structure. 2007 syllabuses conformed to the Curriculum 2000 A level physics criteria.

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

The previous review identified the following key changes to A level physics between 1996 and 2001:

- an increase in the entry for modular syllabuses, which increased emphasis on the application of physics. The wide range of content covered by the modular

schemes made them more demanding overall than the equivalent linear schemes.

- a reduction in the range of assessment tasks, with increased use of more structured questions. This change eased demand slightly.

Overall in 2001 there were differences between awarding bodies in the content of the syllabuses, style of assessment and availability of options. These differences had not led to significant variations in demand except for WJEC, which was felt to be more demanding than other syllabuses, largely due to the mathematical demand.

Materials available

Reviewers considered the syllabus documents, examiners' reports and question papers with associated mark schemes from each of the awarding bodies in 2001 and 2007. Details of the syllabuses included in the review are given in Appendix A.

Assessment objectives

The assessment objectives in the 2001 syllabuses varied between awarding bodies, both in terms of the number of objectives and the description and range of each one. For example, AQA specified three assessment objectives, whereas WJEC specified five. Although these variations were largely superficial, they made comparisons between syllabuses more difficult. The weightings for each assessment objective also varied. For example, the weighting ascribed to practical skills varied from 20 per cent (Edexcel) to 16.7 per cent (OCR).

By 2007 all the awarding bodies had adopted a common scheme of four assessment objectives in accordance with the subject criteria. These were:

AO1: Knowledge with understanding

AO2: Application of knowledge and understanding, synthesis and evaluation

AO3: Experiment and investigation

AO4: Synthesis of knowledge, understanding and skills.

In general the weighting for the assessment objective for experimental and investigative skills fell between 2001 and 2007. In 2001 all awarding bodies allocated 20 per cent to this assessment objective, with the exception of OCR, which allocated 16.7 per cent. In 2007 the allocation for the equivalent assessment objective (AO3) varied from 17.5 per cent (Edexcel) to 12.5 per cent (AQA). The weightings for

practical work also fell correspondingly. In addition, CCEA, OCR and WJEC used the A2 practical work to assess AO4 as well as AO3.

The major change in 2007 was the introduction of an explicit assessment objective for synthesis (AO4). This requirement could have acted to increase demand. However, because of the overlap between this assessment objective and AO1 and AO2, any actual increase in demand depended on how synoptic assessment was implemented in practice, ie in the scheme of assessment and the question papers (see Schemes of assessment' and 'Question papers' sections above).

Reviewers judged that the changes to assessment objectives had no significant impact on demand.

Syllabus content and options

The syllabuses showed a reduction in content between 2001 and 2007. This was particularly the case at AS level where some of the more abstract concepts and the more mathematically challenging work had been transferred to the second year of the course and the overall content was also reduced. The overall effect was to reduce demand slightly at A level and at AS level. Reviewers judged that the changes at AS were appropriate and improved progression from GCSE.

There were significant variations in content between the awarding bodies in 2001. These variations were less pronounced in 2007.

In 2001 the AQA syllabus allowed a wide range of options to be taken. By 2007 the range of options and the content covered by them had reduced significantly. The compulsory part of the syllabus contained more modern physics, especially particle physics, than in 2001. In 2001 options constituted 50 per cent of the course and were chosen from a list of physics and non-physics options, for example candidates could elect to study a module from chemistry, geology or public awareness of science. In 2001 demand across options was uneven. Some optional modules were considered to be very demanding, with a large amount of highly technical content. For example, the astronomy module (module 4) covered methods of finding distances to stars, comparisons of different telescopes, the merits of different detectors including Charged Coupled Devices and the classification of stars. By contrast, other options such as public awareness of science were less demanding. By 2007 the range of options had reduced and content was considered more manageable and more consistent in demand. The AS course had no options and candidates were restricted to one option at A2 chosen from a list of five units, all of which were physics topics. This option now represented less than 10 per cent of the A level assessment.

The CCEA syllabus also showed a reduction in content, particularly at AS level. The first two units in the 2001 syllabus covered exponential decay in the contexts of radioactivity and capacitor discharge. By 2007 these difficult topics had been moved to A2 along with other topics such as circular motion and simple harmonic motion. These mathematically challenging topics were replaced with medical physics at AS. In 2007 modern topics such as particle physics had been added at the expense of more depth in traditional topics, for example candidates were not required to cover the concept of potential in gravitational or electric fields. These changes had the effect of reducing demand at A level.

The Edexcel syllabus reduced the range of content covered between 2001 and 2007. In 2001 the demand was judged to be inappropriately high due to the extensive nature of the content covered in the options. In 2007 candidates could only take one option at AS level and none at A2, rather than two at A level standard as in 2001.

OCR also reduced the number of optional units taken from two in 2001 to one in 2007. In 2001 there was a very wide range of options from which candidates could choose. Candidates for A level took three compulsory papers and two from six option modules. There were 15 ways of selecting two physics modules and an additional 12 ways of selecting one physics and one complementary module, giving 27 routes for the written papers. For each of these there were four ways of completing the experimental skills assessment giving 108 different optional routes. Reviewers judged that this made it difficult for OCR to ensure comparability of demand between options. Furthermore, some of the optional modules (the ‘complementary options’) were not explicitly physics-based, for example scientific communication. Reviewers judged that the range of options was too high in 2001 and that the reduction was appropriate.

The WJEC syllabus was considered the most demanding of those reviewed both in terms of the range and nature of content covered. This was the case both in 2001 and 2007. The syllabus contained most of the content covered by the other awarding bodies, as well as extra topics which rarely appear at A level, for example a demanding section on AC theory which required a derivation of resonant frequency for an inductance, capacitance, reactance circuit. Although there was some reduction between 2001 and 2007, this was still a demanding syllabus in terms of content.

Reviewers concluded that between 2001 and 2007 there was an overall reduction in content at AS, with many of the demanding topics shifting to A2. This was an intended design feature of the revised A level structure and improved progression from GCSE. There was also a reduction in optional routes and in the range of content covered by options. With fewer optional routes available to candidates, content became more manageable and also more consistent in demand both within and across awarding bodies. While some of the more demanding options available in

2001 were dropped, this was offset to some extent by the removal of non-physics options offered by some awarding bodies.

Scheme of assessment

The main change to the schemes of assessment between 2001 and 2007 was a reduction in the number of optional routes available to candidates. In 2001 several awarding bodies offered a wide choice of optional routes. AQA allowed candidates to choose three modules, which amounted to 50 per cent of the course. AQA and, to a lesser extent, OCR allowed candidates to include modules from other subjects, such as geology, chemistry or electronics, as part of their assessment. By 2007 neither awarding body offered this option. Reviewers judged that the range of options in 2001 was excessive, for example the OCR syllabus offered candidates 108 possible different routes. This made it difficult for awarding bodies to ensure comparability across optional routes. Reviewers welcomed the rationalisation by 2007.

In 2001 the total examining time varied from 11 hours and 5 minutes (Edexcel) to 8 hours (CCEA). In 2007 the variation was less, ranging from 11 hours and 15 minutes (AQA) to 9 hours 30 minutes (CCEA), with most syllabuses requiring around 10 hours of examination time.

Reviewers judged that reduction in the number of options available in 2007 increased demand slightly in some syllabuses, in particular AQA and OCR. However, they considered that this was outweighed by other factors, notably the reduction in content of the options themselves. Overall it was judged that the changes to the schemes of assessment had had little impact on overall demand.

Table 5 shows the schemes of assessment in 2001 and 2007.

The codes for each type of assessment are:

E = Externally set and marked
I = Internally set and marked, and externally moderated
W = Written exam
C = Coursework
OT = Objective questions of different types – electronically marked
PEx = Practical examination, externally set and marked.

Table 5: Schemes of assessment for each awarding body in 2001 and 2007

Awarding Body	2001	2007
AQA	3 compulsory units and 3 optional units from a choice of 13 Each unit 1h 30, weighted at 16.6% Within each unit: EW 13.6% IC 3% ***Total A level exam time = 9h***	**AS** Unit 1 and 2 1h (each) EW 15% Unit 3[1] 1h EW 12.5% And either C 7.5% or 1h 45 PEx 7.5% ***Total AS exam time = 3h → 4h 45*** **A2** Unit 4 1h 30 EW (&OT) 15% Unit 5[2] 1h 15 EW 10% And either C 5% or 1h 45 PEx 5% Unit 10 (Synoptic) 2h EW 20% ***Total A level exam time 7h 45 → 11h 15[3]***
CCEA	Units 1–4 Each unit 1h 30 EW 20% Unit 5 2h PEx 20% ***Total A level exam time = 8h***	**AS** Unit 1 and 2 1h (each) EW 16.7% Unit 3A 45min EW 9.2% Unit 3B 1h15 PEx 7.5% ***Total AS exam time = 4h*** **A2** Unit 4 1h 30 EW 15% Unit 5 1h 30 EW 15% Unit 6A 1h EW 8.3% Unit 6B 1h 30 PEx 11.7% ***Total A level exam time 9h 30***

[1] Unit 3 includes written paper AND either practical exam or coursework.

[2] Unit 5 includes written paper AND either practical exam or coursework.

[3] Depending on whether coursework or practical examination option is taken.

Edexcel	4 x module tests Each unit 1h 20 EW 15% Synoptic unit 2h EW 20% Practical 1h 15 PEx 10% 2h 30 PEx 10% ***Total A level exam time = 11h 05***	**AS** Unit 1 and 2 1h 15 (each) EW 15% Unit 3/01 30 min EW 10% Unit 3/02 1h 30 PEx 10% ***Total AS exam time = 4h 15*** **A2** Unit 4 1h 20 EW 15% Unit 5/01 1h EW 7.5% Unit 5/02 1h 30 PEx 7.5% Unit 6 (Synop) 2h EW 20% ***Total A level exam time = 10h 30***
OCR	5 x module tests Each unit 1h 30 EW 16.6% Practical 3h PEx 16.7% or Coursework IC 16.7% ***Total A level exam time = 7h 30 → 10h 30***	**AS** Unit 1 and 2 1h (each) EW 15% Unit 3 45min EW 10% And either: C 10% OR 1h 30 PEx 10% ***Total AS exam time = 2h 45 → 4h 30*** ***A2*** Two units 1h 30 (each) EW 15% Unit 2826 1h 15 EW 10% And either C 10% OR 1h 30 PEx 10% ***Total A level exam time = 7h → 10h***
WJEC	4 module tests Each unit 1h 20 EW 16% Synoptic 1h 40 EW 16% Coursework IC 20% ***Total A level exam time = 7h***	**AS** Unit 1 and 2 1h 30 (each) EW 17.5% Unit 3 2h PEx 15 % ***Total AS exam time = 5h***

Options

The main change to the schemes of assessment between 2001 and 2007 was the reduction in the number of optional routes available to candidates. . Some options had a mathematical emphasis, for example AQA's applied physics module, while others, such as AQA's medical physics option, demanded more of the candidates in terms of written explanation. In some cases this may have allowed candidates to select options according to their strengths, in which case a reduction in options may have increased demand. However, in many schools and colleges the choice of

options is likely to have been a teacher-led decision, with little room for personalised choice.

Question papers

The AS was a new standard, designed to be lower than A level and pitched at what candidates could be expected to do at the end of one year of post-GCSE study. It was a different standard from the 2001 Advanced Supplementary qualification. The AS question papers in 2007 were therefore designed to be less demanding than the A level question papers in 2001. The main issues for reviewers were therefore to consider whether the AS question papers were of an appropriate level of demand for AS and whether the awarding bodies were comparable in their demands at AS.

Reviewers found that changes to the nature of AS increased accessibility to the early modules, typically those studied in the first year of an A level course, in 2007 as compared to 2001. This improved continuity and progression from GCSE. Despite this slight reduction in demand in the first year of the course, reviewers found that there was little change in the overall demand presented by A level physics question papers between 2001 and 2007. There were some variations across the awarding bodies.

The AQA question papers were considered to be the most demanding in 2007 across the awarding bodies, and their A2 papers were thought to be significantly more challenging than the A level papers of 2001. This was principally due to a large number of mathematical questions at AS and A2, and a challenging synoptic paper at A2. Although the questions were well structured, the calculations required were often demanding. For example, one AS question demanded a quantitative analysis of the temperature changes that occur when a known mass of ice is added to water.

There was little difference in the overall demand posed by CCEA A level papers between 2001 and 2007, although the AS papers in 2007 were considered to be undemanding compared to the other awarding bodies. This was due to the nature of the questions in 2007. The questions required lower comprehension skills and brief written responses. This may have been a consequence of trying to maintain the breadth of the examination, despite a reduction in the length of the paper (1 hour in 2007 as opposed to 1 hour 30 minutes in 2001). In 2007, compared to the other awarding bodies, the AS papers relied too heavily on the recall of basic facts, and calculations tended to be straightforward and were not set in context. At A2 the CCEA question papers were in line with the other awarding bodies. Candidates were expected to apply their knowledge and understanding, and mathematical skills, to some unfamiliar situations, such as the use of log scales to interpret an ultrasound scan or the analysis of oscillations from a see-saw.

The question papers from Edexcel were equally demanding at A level in 2007 and 2001. In 2007 the AS papers were highly structured and contained some easier initial questions, which improved accessibility for weaker candidates. The synoptic paper in 2007 was a demanding paper with no optional routes.

The OCR question papers were equally demanding in 2001 and 2007 at A level. Reviewers considered that this level of demand was appropriate. In both years the question papers had a suitable incline of difficulty through the papers. In 2007 the AS papers were more accessible to less able candidates and contained some questions which were clearly aimed at GCSE level, for example Q1 in paper 2822 where candidates had to identify symbols in an equation, filling in boxes to label a diagram. The practical examination was challenging and required candidates to plan, collect, process and analyse data. Some of the A2 papers were very challenging with complex, multistage calculations, including one where candidates had to find the air pressure at the top of Mount Everest.

Reviewers found WJEC papers to be appropriately demanding in both years. The AS papers in 2007 were more challenging than other awarding bodies. The demand of the papers in both years was increased by the requirement for candidates to recall many of the standard formulae which were routinely provided to candidates by other awarding bodies, often in the form of a formula sheet which was absent from the WJEC syllabus. There was a good range of question types in each year. In 2007 the questions tended to be shorter and limited to about 3 marks, but they were often set in context, which was not the case in 2001.

Reviewers commented on the excellent layout and presentation of the AQA, OCR and WJEC question papers, particularly in 2007. They were concerned that some of the CCEA question papers were rather crowded, making it more difficult for candidates to follow. The content and layout of the mark schemes also improved between 2001 and 2007. This was particularly the case for WJEC, where the range of acceptable answers was given in more detail and the quality of presentation greatly improved in 2007.

Synoptic assessment was formally addressed through a separate assessment objective, AO4, in 2007. Most of the awarding bodies dealt with this through a separate written examination paper. CCEA divided the synoptic assessment over all three written papers and the practical assessment at A2. WJEC assessed AO4 through a written paper and a coursework task. OCR also attributed some of the synoptic assessment to practical work.

Reviewers judged that synoptic questions were successful when candidates were faced with an unfamiliar context and were required to select and apply the relevant physics knowledge and understanding to the solution of the problem. For example, the AQA synoptic paper required recall from across the syllabus and the questions on

applications demanded a detailed understanding. A question on Rutherford scattering asked candidates to explain the need for collimation and for a thin target. Candidates were expected to apply their knowledge to some unfamiliar contexts, which would have stretched the most able. Another successful approach was in the testing of skills developed throughout the course, for example the WJEC synoptic paper, PH6, had a data analysis question which tested graphical and analytical skills in a novel situation.

However, reviewers were concerned that the degree of synthesis required of candidates in general was limited and often did not significantly add to the demand of the assessment. This was compounded in some cases by the fact that synoptic questions were often heavily structured and only required short answers from candidates. In the OCR synoptic paper *Unifying concepts in physics*, candidates were asked to apply the idea of exponential decay to cooling of liquids and hence to finding the half-life temperature of a cup of tea. While reviewers liked this approach, they found that the paper overall was less demanding, as there were no opportunities for extended writing which might be expected on a synoptic paper. Some of the questions were trivial and made few demands on physics knowledge, for example one question asked candidates to 'State and explain two reasons why people do not like living near power stations'. Some of the targeting of questions was doubtful, for example in one instance, reviewers considered targeting at higher attainment levels inappropriate.

Practical work: coursework and practical examinations

Table 6 shows how practical work was assessed in 2001 and 2007:

Table 6: Nature of practical work assessment in 2001 and 2007

Awarding Body	2001 : Nature	2001: Weighting	2007 : Nature	2007: Weighting
AQA	coursework: one assessed practical with each of the six modules.	6 x 3% Total 18%	coursework or practical examination 1h 45 (In AS and A2)	AS 7.5% A2 5% Total 12.5%
CCEA	practical test 2h	20%	AS practical test 1h 15 A2 practical test 1h 30	AS 7.5% A2 11.7% Total 19.2%
Edexcel	AS practical test 1h 15 A level practical test 2h 30	20%	AS practical test 1h 30 A2 practical test 1h 30	AS 10% A2 7.5% Total 17.5%
OCR	coursework or	16.7%	coursework or	AS 10% A2 10%

	practical exam 3h		practical exam 1h 30 (In AS and A2)	Total 20%
WJEC	coursework	20%	AS practical test 2h A2 practical coursework	AS 15% A2 7.5% Total 22.5%

The weighting given to the assessment of practical work varied from 16.7 per cent (OCR) to 20 per cent (CCEA, Edexcel, WJEC) in 2001 and from 12.5 per cent (AQA) to 22.5 per cent (WJEC) in 2007. The assessment was achieved either by externally set and assessed practical examinations or internally set and assessed, externally moderated coursework. Overall there was more variation across the awarding bodies in terms of weighting for practical work in 2007 than in 2001 and the weighting for the assessment objective relating to practical skills (AO3) fell. This is discussed in the section on 'Assessment objectives' on page 28. In 2001 awarding bodies targeted only the assessment objective relating to practical skills in practical work. In 2007 CCEA, OCR and WJEC targeted AO4 (synthesis of knowledge, understanding and skills) in practical work, as well as AO3 (experiment and investigation). WJEC also additionally attributed some of the assessment to AO1 (knowledge with understanding) and AO2 (application of knowledge and understanding, synthesis and evaluation) in the AS practical work.

By 2007 all the awarding bodies offered a practical exam, at least as an optional alternative to coursework. The WJEC syllabus assessed practical skills through an exam at AS and through coursework at A2. The AQA and OCR syllabuses continued to offer a choice between coursework and a practical examination.

The most significant change to the assessment of practical work occurred with AQA. In 2001 AQA candidates had to present an assessed practical with every module. This was excessive and sometimes it was difficult to design practical work appropriate to the content of each module, for example particle physics. The differentiation was poor for the coursework assessment. By 2007 the requirements had been reduced to one piece of coursework at AS and one at A2. The option of a practical exam had also been introduced. The skills that were assessed were specified in more detail than in 2001 and were identical in the coursework and the practical option. This helped to ensure comparability across the two routes. The planning sections of the practical examinations at AS and at A2 were considered to be imaginative and challenging.

No coursework option was available in the CCEA syllabus. The practical examination tasks were considered to be very challenging in both years. For example the AS practical in 2007 required candidates to take measurements of the refraction through a glass block and plot sin *i* against sin *r* and find the gradient, as well as carry out

current-voltage measurements to find the resistance and diameter of wire. Reviewers judged this to be a demanding test in the time available, which was only 1 hour 15 minutes.

The Edexcel syllabus did not offer a coursework alternative. The practical examinations were appropriately demanding in both years. The assessment of planning skills was more evident in 2007.

The coursework assessment criteria in the OCR syllabus changed between 2001 and 2007. The number of skill areas changed from three to four, with more emphasis on evaluation in 2007. The criteria for all skills were made more explicit. However, this did not have a significant impact on demand, which reviewers considered to be broadly appropriate in both years.

In the 2001 WJEC syllabus, the assessment of practical work was designed to be integrated into normal laboratory work, rather than being a separate assessment task. There was a series of 20 separate skills that candidates could demonstrate during practical work. Candidates found this assessment less demanding than the written examinations, since 93 per cent of candidates gained grade C or above on the practical assessment, compared to only 50 per cent for the written papers. By 2007 this scheme had been replaced with a practical test at AS and coursework at A2. The AS practical test was appropriately demanding, but did not assess planning skills. These were assessed in the A2 extended investigation, designed to take between 10 and 15 hours of class time. Reviewers judged that this combination of assessments was more demanding than in 2001.

Overall, reviewers commented that the practical examinations were particularly successful at assessing practical skills, including planning and evaluation. They concluded that the assessment of practical skills was likely to be more rigorous under the controlled conditions of a practical examination.

Summary

Reviewers found that the overall demands of the GCE A level examinations in physics had not changed significantly between 2001 and 2007. In both years the demands were considered appropriate. There were some changes that increased demand in 2007 and others that reduced it, but their overall impact was considered to be neutral.

The main changes were:

- the rationalisation of assessment objectives, with the introduction of synoptic assessment as a formal requirement for all syllabuses. This led to a slight increase in demand, although this varied across awarding bodies, depending on how synoptic assessment had been realised

- a general reduction in the weighting given to practical skills between 2001 and 2007
- the introduction of less demanding AS unit assessments
- the movement of content, especially the more abstract and challenging content to A2 units
- a reduction in the range of options available, which gave candidates fewer opportunities to play to their strengths
- a slight reduction in the overall content covered by candidates choosing the most popular routes through syllabuses in 2001 and 2007.

Standards of performance at A level

Reviewers considered candidates' work from all the awarding bodies in 2001 and 2007. The candidates' work supplied for 2001 had evidence of performance in all modules. However, these candidates were often composite rather than real candidates; that is the modules of several candidates were put together to supply one composite candidate at the relevant grade boundary. Reviewers have commented consistently on the difficulty of judging the performance of composite candidates. This is because individual candidates inevitably have varying strengths and weaknesses. With a composite candidate, these strengths and weaknesses become inconsistent. For example, a composite candidate may demonstrate strong mathematical skills in one module and weak mathematical skills in another.

The 2007 candidates supplied were real (not composite) candidates. At the AS grade A and E boundaries reviewers considered three AS units per candidate. At A2 grade A and E boundaries reviewers saw the three A2 units of each candidate.

There were no comparisons of performance at AS over time. This was because the AS was introduced as a new standard in 2002, between GCSE and A level. Advanced Supplementary candidates in 2001 were tested at A level standard.

Further details of the materials used are provided in Appendix B.

Reviewers considered QCA's published AS and A2 performance descriptions for physics in the light of candidates' work reviewed. The report contains amended versions of the performance descriptions that reflect the work seen. On some occasions candidates' work did not match the performance description because candidates failed to demonstrate a particular feature that was tested. On other occasions candidates' performance included additional features that were not reflected in the performance descriptions. There were also instances where candidates' performance did not match the description because the question papers did not require candidates to demonstrate a particular feature.

GCE AS grade A performance descriptor

AO1: Knowledge with understanding

Candidates at this level could normally:

- recall knowledge of physics from the AS syllabus with only a few significant omissions
- show good understanding of the majority of the principles and concepts they used

- select and present relevant information clearly. In addition they could offer logical argument using specialist vocabulary.

There was little opportunity for candidates to demonstrate that they could draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of physics.

AO2: Application of knowledge and understanding, synthesis and evaluation

Candidates at this level could normally:

- apply physical principles and concepts from most of the AS syllabus to both familiar and unfamiliar contexts
- explain and interpret most phenomena and present arguments and evaluations clearly
- interpret and translate accurately data presented in various forms
- carry out structured calculations and demonstrate good understanding of the underlying relationships between physical quantities.

The question papers offered limited opportunity for candidates to apply physical principles and concepts to unfamiliar situations, including those that relate to the ethical, social, economic and technological implications and applications of physics.

There was also very little evidence that candidates could assess the validity of physical information, experiments, inferences and statements because the question papers did not present sufficient opportunities to do so.

A03: Experiment and investigation

Candidates at this level could normally:

- devise a clear plan in experimental activities
- use relevant techniques safely and skilfully to make and record measurements – with appropriate precision – to provide sufficient evidence
- show good understanding of AS physics in their interpretation of their results
- evaluate the reliability of their methods and the validity of their conclusions.

Reviewers noted that some assessments gave only limited opportunities for candidates to demonstrate the last two points.

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

Standards of performance were uneven across the awarding bodies at this grade boundary. AQA and OCR candidates were judged to demonstrate a higher standard of performance, while CCEA, Edexcel and WJEC candidates were generally found to be of a lower standard.

AQA and OCR candidates tended to show deeper and more consistent knowledge and understanding across a wider range of topics. They had very good problem-solving skills and their calculations were more accurate. They tended to demonstrate stronger practical skills with better descriptions of methods in their experiments. While candidates from the other awarding bodies were able to demonstrate good knowledge, understanding and skills in some areas, their responses tended to have more gaps and errors. However, reviewers did comment that CCEA candidates showed very good practical skills.

GCE AS grade E performance descriptor

AO1: Knowledge with understanding

Candidates at this level could normally:

- recall knowledge of physics from parts of the AS syllabus
- show limited understanding of the principles and concepts they used
- select and present information, where some guidance was given.

Reviewers were, however, concerned that candidates presented information with inconsistent use of scientific terminology.

AO2: Application of knowledge and understanding, synthesis and evaluation

Candidates at this level could normally:

- apply, with limited consistency, physical principles and concepts from parts of the AS syllabus
- provide basic explanations and interpretations of some phenomena, presenting some limited evaluation
- interpret data which showed simple patterns and trends
- carry out structured calculations.

Reviewers were concerned that candidates' application of principles and concepts was often confined to topics already encountered at GCSE.

A03: Experiment and investigation

Candidates at this level could normally:

- devise a basic plan in experimental activities
- use relevant techniques safely to make measurements and also record and tabulate data
- show some limited understanding of AS physics in their interpretation of their results
- carry out a basic evaluation of their methods
- present evidence in a graphical form.

Reviewers were concerned that although candidates could record and tabulate data, this was sometimes limited in range and quantity. Evaluations of their methods were often incomplete and they showed some inadequacies in their presentation of graphical evidence.

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

Standards of performance across AQA, Edexcel and OCR were broadly comparable. WJEC candidates were judged to be slightly stronger, while CCEA candidates were found to be weaker.

WJEC candidates demonstrated better general knowledge and understanding of physics and their numerical work and practical skills were stronger. They performed strongly on more challenging questions, as well as on similar questions to their counterparts from the other awarding bodies. While CCEA candidates often had strong practical skills, they demonstrated uneven knowledge and understanding across the range of topics. Their answers showed significant misunderstandings and they struggled to use terminology correctly. Their numerical and problem-solving skills were also weaker.

GCE A level grade A performance descriptor

AO1: Knowledge with understanding

Candidates at this level could normally:

- recall physics from most parts of the A2 syllabus
- retrieve, interpret and present information in questions where significant guidance was not given
- select and present information coherently in descriptions or explanations using accurate physics terminology, in both familiar and unfamiliar situations.

AO2: Application of knowledge and understanding, synthesis and evaluation

Candidates at this level could normally:

- answer numerical problems across a wide range of topics in the A2 syllabus
- use complex mathematical models, such as exponential change
- show understanding of the some of the more abstract and complex ideas in the A2 syllabus, such as the photoelectric effect and electromagnetic induction.

Reviewers noted that candidates were often more successful in numerical questions than in questions that demanded a written explanation. They also noted that candidates tended to gain more marks for knowledge and understanding (AO1) than for application (AO2). They showed a high level of knowledge of the topics in the syllabus and had some success in applying these ideas, but found it difficult to sustain a high level throughout the examination.

AO3: Experiment and investigation

Candidates at this level could normally:

- produce a plan for investigation
- carry out experimental procedures effectively and present the data appropriately
- use significant figures and units, including those for derived quantities, with a high level of accuracy
- analyse data using logarithmic analysis
- attempt an evaluation, for example by calculating uncertainties.

Reviewers noted that candidates' plans for investigations were sometimes incomplete and that they were often unable to calculate compounded uncertainties when attempting an evaluation.

AO4: Synthesis of knowledge, understanding and skills

Candidates at this level could normally:

- draw on knowledge and understanding from the range of AS and A2 topics, with some guidance
- comprehend a passage on a novel topic and respond successfully to some of the questions relating to the topic
- apply mathematical and analytical skills with reasonable consistency, including questions set in novel contexts or those requiring data analysis
- demonstrate some ability to understand information and data when presented with extended passages in novel situations.

Reviewers noted that the degree of synthesis required from candidates was limited. Some synthesis of ideas was built in to topics in the A2 course, for example the use of mechanics in work on the kinetic theory. Where questions were set on novel situations, they tended to lead candidates to the required physics.

Performance at GCE A level grade A over time

There was some evidence of a decline in the standards of performance within each awarding body between 2001 and 2007 at this grade boundary. This was particularly marked for CCEA and OCR.

Reviewers commented that candidates in 2001 demonstrated greater consistency in their knowledge and understanding across the topics. However, it must be taken into account that reviewers saw evidence of 2001 candidates' performance in all modules, rather than in just three A2 units, as was the case for the 2007 candidates. Reviewers also commented that it was difficult to compare 2007 candidates with the composite candidates supplied for 2001.

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

Standards of performance were broadly comparable across the awarding bodies at this grade boundary.

GCE A level grade E performance descriptor

AO1: Knowledge with understanding

Candidates at this level could normally:

- recall physics concepts and principles from some parts of the A2 syllabus
- show some understanding of the principles and concepts in the A2 syllabus in familiar contexts
- show understanding of some of the more complex ideas, such as electromagnetic and gravitational fields
- select and present information to provide descriptions or explanations.

Reviewers noted that although candidates were able to recall physics concepts and principles, they often made limited progress with more complex ideas. Candidates also tended to make errors due to a lack of mathematical skills. They were able to use correct physics terminology, provided that guidance was given and that the situations were familiar but they found novel situations more difficult.

AO2: Application of knowledge and understanding, synthesis and evaluation

Candidates at this level could normally:

- apply physical principles and contexts in situations from the more straightforward parts of the A2 syllabus, such as capacitors
- provide some basic explanations of A2 concepts
- interpret data which showed straightforward patterns
- carry out some calculations in A2 contexts when guidance was given
- present arguments which made relevant points.

Reviewers were concerned that candidates showed limited ability to apply principles and contexts in the more demanding concepts, such as fields or thermodynamics. Their explanations of more complex ideas were often flawed. They also presented arguments that lacked fluency or contained errors or important omissions.

AO3: Experiment and investigation

Candidates at this level could normally:

- devise an appropriate basic plan for investigating a relationship in an A2 context

- use suitable techniques to obtain data to provide relevant evidence for the investigation and could present this evidence in a suitable form
- apply their physics knowledge and understanding to interpret their results, though often with limited success
- produce a basic evaluation of the experiment.

Candidates were more likely to be successful at collecting and analysing data, and in relating this to their physics knowledge than in devising clear plans for experiments in novel situations. They also found it difficult to produce evaluations that related to specific experimental procedures.

AO4: Synthesis of knowledge, understanding and skills

Candidates at this level could normally:

- use some physics concepts from different areas of the syllabus in an attempt to analyse a novel situation, although not always successfully or completely
- interpret and represent data in graphical or tabulated form.

Performance at GCE A level grade E over time

There was an uneven pattern in the standards of performance between 2001 and 2007 at this grade boundary. For CCEA, Edexcel and WJEC there was an increase in the standards of performance, while AQA and in particular OCR saw a decline in the standards of performance over the period.

Reviewers commented that when responding to similar questions, CCEA and WJEC candidates in 2007 gave better answers than their 2001 counterparts. They had more basic knowledge across a wider range of topics and were able to attempt a few calculations with more success.

By contrast OCR candidates in 2001 had fewer gaps in their knowledge and were able to write in more detail. Their numerical skills and use of scientific terminology were also better. AQA candidates in 2001 made fewer basic errors and were better at application. As at grade A, reviewers commented that it was difficult to compare 2007 candidates with the composite candidates supplied for 2001 and also that the 2001 candidates had evidence of their performance in all modules, whereas for the 2007 candidates reviewers saw only the three A2 units.

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

Standards of performance were broadly comparable across the awarding bodies at this grade boundary.

Summary

The structural differences between the 2001 A level and the new AS/A2 package made it very hard to compare standards between 2001 and 2007. Reviewers also commented on how difficult it was to compare the performance of composite candidates from 2001 with that of candidates in three A2 units in 2007.

Between 2001 and 2007 there was some evidence of a decline in standards of performance at A level grade A and this was particularly marked for CCEA and OCR candidates. At A level grade E the pattern was uneven, with AQA and especially OCR seeing a decline in standards of performance, while CCEA, Edexcel and WJEC candidates were judged to be stronger in 2007.

In 2007 there was variation across the awarding bodies in the standards of performance at AS grades A and E. At AS grade A AQA and OCR candidates were judged to demonstrate a higher standard of performance, while CCEA, Edexcel and WJEC candidates were found to be weaker. At AS grade E, AQA, Edexcel and OCR candidates demonstrated broadly comparable standards of performance, while WJEC candidates were judged to be stronger and CCEA candidates, once again, were found to be weaker.

At A level grades A and E the picture in 2007 was more even and standards of performance were broadly comparable across the awarding bodies.

Progression across the levels

The introduction of AS level in 2000 was designed to place an intermediate stage between GCSE and full A level standard. Reviewers were asked to consider issues of progression from GCSE to A level in 2001, before the introduction of AS. They also considered the situation in 2007 when the progression was in two stages, GCSE to AS level and AS to A level.

In 2001 reviewers found that GCSE physics was good preparation for A level study. This was true across all awarding bodies, though there were some variations. GCSE question papers were sometimes too structured and did not provide enough demand for able candidates. This was particularly true of the Edexcel papers. In some syllabuses, such as AQA, the relevance of GCSE work depended to some extent on which options were taken at AS.

In 2007 the progression from GCSE to AS level in terms of content was considered to be largely appropriate for all the awarding bodies. Some individual AS questions did not progress much beyond GCSE; indeed some questions could have appeared on a GCSE question paper. However, taken as a whole the question papers did represent an appropriate increase in demand from GCSE.

Clear progression could be seen at AS in terms of an increased emphasis on quantitative work. At GCSE much of the work was qualitative or required only basic mathematical skills. Candidates only needed to be familiar with a few relatively simple mathematical models. For example, the study of electricity at GCSE involved calculations using equations such as $V = IR$ and $P = VI$, while at AS an understanding of the equation $I = nAvq$ and the concept of resistivity was expected.

Reviewers observed that marking schemes clearly showed the increase in demand. At GCSE there were a large number of questions in which short or one-word answers (often with no alternatives) provided an adequate response. AS mark schemes often allowed for a wider variety of responses, which indicated more open-ended questions, often requiring understanding rather than simply recall.

In 2007 the progression from AS to A2 was also felt to be broadly appropriate for all the syllabuses being reviewed. The main change between AS and A2 was the inclusion of synoptic assessment, which required knowledge and understanding of the whole AS and A2 content.

The A2 syllabus often contained more abstract topics than the AS, for example electromagnetic induction and the study of fields. The demand at A2 was enhanced by the nature of these topics, so that although the type of question did not change significantly, the level of comprehension required tended to be higher. For example, a question on the electro magnetic force induced in a bicycle wheel spinning in the

earth's magnetic field required clear thinking in a novel situation (Edexcel module PHY5). The more challenging mathematical concepts were also reserved for A2, such as the use of logarithms to solve problems on capacitor discharge or radioactive decay.

Progression between AS and A2 was clear in some topics. In mechanics for example, AS study of linear motion and Newton's laws progressed to the more challenging concepts of circular motion and simple harmonic motion. In other areas progression was less clear and some topics suffered through fragmentation. For example, in the AQA syllabus the study of particle physics at AS and the physics of nuclear power at A2 (in module 4) was succeeded by the study of radioactivity in the final module.

The practical skills developed at GCSE were an excellent preparation for A level work. The GCSE criteria stressed the importance of scientific knowledge and understanding, particularly when identifying key variables and planning an investigation. The criteria at A level build on this but also demand specific, quantitative practical skills, such as allowing for zero errors, recording results to an appropriate number of significant figures and calculating derived quantities, for example by finding the gradient of a graph.

Appendix A

Details of A level and GCSE syllabuses reviewed

Syllabus codes of A level and GCSE syllabuses reviewed

Year	Awarding body and syllabus				
	AQA	**CCEA**	**Edexcel**	**OCR**	**WJEC**
2002 – GCSE	1181	G76	1046	1782	020001/2
2007 – GCSE	3453 (modular) 3451 (linear)	G76	1549	1982	020001/2
2001 – A level	4183	A76	9541	9536	032/632
2007 – A level	6451	A1210	9540	7883	082/90

Appendix B

Numbers of GCSE scripts reviewed

Awarding body	AQA			CCEA		Edexcel		OCR	
Year	**2002**	**2007 (modular 3453)**	**2007 (linear 3451)**	**2002**	**2007**	**2002**	**2007**	**2002**	**2007**
GCSE Grade A	10	5	10	5	5	8	6	5	10
GCSE Grade C (Higher tier)	6/	8	10	5	4	5	4	5	8
GCSE Grade C (foundation tier)	10	5	10	5	4	5	5/	8	10
GCSE Grade F	4	5	4	No scripts	No scripts	2	5	No scripts	4

Numbers of GCE scripts reviewed

Awarding body	AQA		CCEA		Edexcel		OCR	
Year	**2001**	**2007**	**2001**	**2007**	**2001**	**2007**	**2001**	**2007**
AS Grade A		10		10		8		8
AS Grade E		6		3		4		8

A Level Grade A	10	8		6	5	4	10	12	5
A Level Grade E	10	6		3	4	4	10	9	4

Appendix C

List of reviewers

Review team	
Coordinator	Dave Kelly
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Script reviewers	Angela Skinner Clifford Essex David Homer Nigel Wood Iestyn Morris Robert White Chris Mee Geoff Goodwin Howard Dodd Brian Turner John Avison Chris Honeywill Pauline Anning Stephen Turp Clare Thomson

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