PHYSICS IN SCHOOLS AND UNIVERSITIES
II. Patterns and Policies

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Executive Summary

The Gatsby Charitable Foundation has commissioned the Centre for Education and Employment Research at the University of Buckingham to compile a comprehensive numerical picture of the flows of physics students from school to university through secondary analysis of available data.

Key Findings

- Since 1990 entries for A-level physics have fallen by 35.0%, while entries overall have risen by 12.1%. The annual rate of decline was 2.5 times greater in the period 1990-96 immediately following the introduction of the combined science GCSEs than it has been subsequently.
- The drop between 1990 and 1996 occurred mainly in the comprehensive schools, sixth form colleges and further education colleges, with independent and grammar schools less affected.
- From its inception in 1951 the take-up of O-level physics increased by more than eightfold to 1989, but following the introduction of combined science GCSEs it has fallen back to less than a quarter of its peak. Thus while all pupils in maintained schools now study some physics as part of science, fewer are specialising. The switch from GCSE physics has occurred mainly in comprehensive schools.
- Between 1994 and 2004, 17 university physics departments admitting more than ten students per year closed. Counting all departments with any physics students, the loss has been 24. At the same time first-year full-time UK-domiciled students reading physics fell by 905 (28.9%), including 166 from the 26 top-rated departments in the 2001 RAE (8.2%). A rank order correlation by region showed the drop in student numbers to be significantly correlated with departmental closures.
- The impact of the fall in A-level entries on university intake has been ameliorated to some extent by a higher pass rate, up from 73.9% in 1990 to 94.2% in 2005, and a higher application acceptance rate, up from 83.4% in 1990 to 96.0% in 2004. Degree classes of graduates have improved, with firsts up by 41.6% and thirds or lower down by 32.7% since 1997.
- Students in independent (14.4% in 2004) and grammar schools (10.2%) are more likely to take A-level physics than those in comprehensives (6.2%) or sixth form colleges (4.0%), but also more likely to read subjects other than physics at university. Even so, second year sixth formers in independent schools are 52% more likely to read physics than those from comprehensive schools.
- In the period 1996-2005, only about 8% of university entrants with A-level physics read physics *per se*. The highest proportions took engineering and technology (25.2%), maths and computing sciences (16.0%), medicine and dentistry (11.8%) and the other physical sciences (9.7%). There has tended to be a shift away from physics itself, the other sciences and medicine and dentistry towards creative arts, architecture and a wide variety of other subjects and combinations.
- Female students were not only less likely to take A-level physics (22.4% of total) but also less likely to read physics at university (18.5% of total), in spite of getting better A-level physics results.

- Irrespective of school background, female students with A-level physics were much more likely to take veterinary science, medicine and dentistry and biological sciences, and much less likely to read engineering and technology, the physical sciences and maths and computing science.
- Science in schools is increasingly taught by biologists. From a third of the science teacher trainees in 1983, physics graduates now comprise only about 1 in 8. Nearly a fifth of the physics graduates in teacher training are training to teach maths rather than science.

Background

Independent schools are commonly held to be the bastion of physics as an identifiable subject in schools. This can be traced back to an analysis of the changing pattern of A-level subject combinations up to 1994. A survey conducted by us last year found major differences between school types, with a higher take-up of A-level physics in independent schools, which also were more likely to offer GCSE physics, to have teachers more high qualified in physics and to achieve the better physics results. In this follow up study we place the survey results in a numerical context and investigate whether the earlier trends have continued.

Methodology

Special analyses were commissioned from the Higher Education Statistics Agency (HESA) and the University and Colleges Admissions Service (UCAS). HESA was able to provide data on universities and first-year full-time UK-domiciled physics students for the years 1994 to 2004 (though with some re-classifications). UCAS was able to provide data on school background and subject choices for the years 1996-2005 (though again with some category changes). We also had available data for the years 1985 to 1993 from the Universities' Statistical Record, the database of the pre-1992 universities, but our USR data set applies only to England and Wales whereas the UCAS data covers the UK. Our examination of the trends, therefore, comes in three steps: changes from 1985 to 1993 from the USR data; changes from 1998 to 2001 based on UCAS data using the old subject classification (1996 and 1997 omitted because of changes to the schools classification); and changes from 2002 to 2005 from the UCAS analyses using the revised subject classification. In addition, we have drawn on various published sources of statistics which are credited on the charts and listed in the references.

Findings

A-Levels: Entries to A-level physics have been falling sharply. Since 1990 they have dropped by 35.0%, while A-level entries overall have risen by 12.1%. The rate of decline was 3.5% per year between 1990 and 1996 compared with an annual 1.4% since. The fall in the earlier period occurred mainly in comprehensive schools, sixth form and further education colleges, with grammar and independent schools less affected. The drop will have been exacerbated by the reduction in the population of 18-year-olds, but it is over and above that, since the proportion of the age group taking A-level physics fell from 5.9% to 3.9%. The gender ratio has hardly changed with female students comprising about 22.4% of the entry. Grades have risen as in other subjects. Since 1990 the pass rate in A-level physics has risen from 73.9% to 96.0%, so while entries have fallen by 17,215, passes are down by only 7,922. The number of A grades awarded has actually increased by 1,719 (27.2%). Entries are higher and pass rates are lower at AS suggesting that those with the poorer performance in the one-year examination tend not to proceed to A-level itself.

O-Level/GCSE*:* The national curriculum and changes to the secondary school exams have had a major impact on the numbers studying physics as a separate subject. There is no one consistent database available, but general trends emerge. Physics take-up during the lifetime of O-level increased by nearly eightfold from 23,200 in England and Wales in 1950 to 196,920 in England alone in 1989. But, in its guise as a GCSE, physics fell to a low of less than a quarter of the peak (43,839 in 1995 in England Wales and Northern Ireland). Meanwhile the double award science GCSE, intended to represent a balanced combination of physics, chemistry and biology, surged in the years immediately following its introduction from 89,949 entries in 1990 to reach 538,210 in 2004. Thus while many more children study some physics to age 16 most do so as part of combined science, and fewer specialise. Entries to GCSE physics have fallen less in independent and grammar schools than in comprehensive schools, where between 1991 and 1994 they dropped from 76,700 to 12,900. Since 1994 there has been some recovery associated with specialist schools in general, but not the science schools in particular. Students taking GCSE physics are a high attaining group, three times more likely to obtain an A*/A grade than those taking combined science – in 2005, 46.9% against 13.9%.

University Places*:* Between 1994 and 2001 the number of UK universities admitting ten or more physics students per year went down from 57 to 42, with the loss of two further departments by 2004. Altogether 78 universities have had departments with at least some physics students since 1994, of which only 54 were extant in 2004. Between 1994 and 2004 first-year full-time UK-domiciled students reading physics fell by 28.9%. This included a decrease of 8.2% in the 26 top-rated research departments. In the other departments student intake more than halved. Scotland, London and the North West lost most departments and this correlated significantly with student decline (+0.683, $P < 0.05$), but other factors also come into play including reputation and research rating. Over the period 1994-2004 applications from home students fell by 22.9%, compensated to some extent by a rise in the acceptance rate from 88.6% to 96.0%. This was not on lower entry grades; the reverse in fact: 39.9% more were admitted on the equivalent of an A and two Bs or higher and 36.3% fewer on the equivalent of a B and two Cs or lower. There has been an upward trend in recruitment from the European Union and overseas, but even so these students amounted to only 8.8% of the intake in 2004.

School Background and Gender: There were falls in the university physics intake from all school backgrounds between 1985 and 2005 except for a small increase from independent schools in the period to 1993. The sharpest reduction was from the further education sector. Proportionally fewer girls read physics at university (18.5%) than take it at A-level (22.4%), in spite of girls obtaining the better A-level results. The percentage of female students reading physics at university between 1994 and 2004 was less a third of that in biology (58.5%) and less than half that in chemistry (40.5%). More girls from independent than maintained schools study physics at university – 23.8% against 16.5%. The proportion in grammar schools is similar to that in independent schools.

Subject Choice: Sixth formers in independent (14.4%) and grammar schools (10.2%) are more likely to take A-level physics than those in comprehensive schools (6.2%) or sixth form colleges (4.0%), but are also more likely to take subjects other than physics at university. Even so, more students from independent schools read physics as a degree subject than students from maintained schools since more take A-level physics.

Overall, only 7.9% of university entrants with A-level physics read physics itself between 1996 and 2005. The highest proportions went to engineering and technology (25.2%), maths and computing sciences (16.0%), medicine and dentistry (11.8%) and the other physical sciences (9.7%). The different school/college types followed this broad pattern but students from independent and grammar schools were more likely to read medicine and dentistry whereas those from comprehensives and sixth form colleges were more likely to take the physical sciences, including physics, and maths and computing sciences. Irrespective of school background, female students with A-level physics were six times more likely than their male counterparts to study veterinary science, three times more likely to study medicine and dentistry, and over twice as likely to take biological sciences, but only half as likely to read engineering and technology or maths and computing. The distribution of subjects studied by students with A-level physics has been relatively consistent from year to year, but with a shift away from physics itself, the other sciences, and medicine and dentistry towards creative arts and design, architecture, building and planning and a wide variety of other subjects and combinations.

Output and Destinations*:* In spite of falling A-level entries and a higher university acceptance rate, 'firsts' in physics have increased by 41.6% and 'thirds or passes' have gone down by 32.7% since 1997. Physics graduates are more likely than other graduates to go on to further study and less likely to enter paid employment directly.

Physics Graduates into Teaching: Relatively few physics graduates enter teaching. There are over three times as many training places in biology as there are in physics. In addition, nearly five times as many biology as physics graduates are recruited to teach combined science. From about a third of the science trainees in 1983 physics graduates now comprise only about one in eight. Science in schools, therefore, is increasingly being taught by biologists. Teacher trainees generally obtain poorer degrees than their fellow graduates. Trainees to teach physics, chemistry and biology tend to hold better degrees than those training to teach combined science. Nearly a fifth of the physics graduates in teacher training train to teach mathematics. These are among those with the best degrees. Females are more likely to enter teaching than males and the small number taking physics degrees contributes to the difficulties in recruiting the teachers. Biology graduates entering teaching are younger than physics graduates. Only 67.2% of the trainee physics teachers achieve qualified status compared to over 80% in biology and chemistry. Successful physics completers were more likely than those in other subjects to be looking for employment outside teaching.

Conclusion

It is evident that physics is in the grip of a long-term trend in which diminishing numbers of students are choosing it as an A-level subject. This is impacting on university intakes. The decline also points to the impoverishment of science education for many pupils lower down the schools. It is very important, therefore, that the science community confronts the issues. Our earlier report offered a number of policy pointers, but the central questions would seem to be: what importance should be attached nationally to identifying and developing students capable of taking physics to a high level, what role should physics play in general education, and how might the desired ends be achieved? The government published *Science and Innovation Investment Framework 2004-2014: Next Steps* in March 2006 containing a number of proposals aimed at improving the quality of teaching and learning. It is important that any policies should be grounded in the numerical picture.

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1. Introduction

1.1 In 2005 the Centre for Education and Employment Research (CEER) conducted a survey of physics in schools and colleges (Smithers and Robinson, 2005). We found that in the maintained sector nearly a quarter of the 11-16 schools had no teacher who had studied the subject to any level at university. Nearly ten per cent of the schools with sixth forms did not offer physics at A-level and nearly 40 per cent had five entries or fewer. Independent schools were much better placed, but although the sixth form and FE colleges had well-qualified physics staff many were struggling to attract students. The physics expertise of the teachers was found to have a big impact on the examination results of the students, second only to pupil ability as a predictor. The stock of teachers expert in physics, however, is diminishing. Their age profile is skewed, with almost double over fifty as are thirty and under. Fewer of the newly appointed teachers than the leavers in 2005 were qualified in physics. More of the teachers of physics aged 21-30 held a degree in biology than in physics. This imbalance in the science background of teachers has been confirmed by the National Foundation for Educational Research (NFER, 2006).

1.2 The present report brings together specially commissioned analyses from the Universities and Colleges Admissions Service (UCAS) and the Higher Education and Statistics Agency (HESA), our own CEER database, and data collected by various agencies, to set these somewhat alarming findings in context. We look at the trends in school examination entries and passes, the number of universities offering physics, university entries by school background and gender, subject choices, graduate output and destinations, including into teaching. The main aim of the study is to provide a comprehensive numerical picture for those in a position to influence and make policy.

1.3 We begin with A-levels because that is where the clearest evidence of a decline in physics in schools is to be found. Entries have fallen sharply since 1989. We ask what has happened during the lifetime of A-levels both to entries and passes, whether different types of school and college have fared differently, and whether there is a gender difference. In order to interpret any trends which emerge we consider the pattern of entries at O-level and GCSE to tease out what bearing this may have had on the take-up of A-levels.

1.4 Data compiled by the Institute of Physics (IoP, 2005) are interpreted by them as indicating that, while numbers at A-level have been dropping and university physics departments have been closing, university physics entries have generally held steady. In Chapter 4 we analyse the data obtained from HESA and find that there has actually been a fall even in the 26 institutions rated 5*/5 for physics in the 2001 Research Assessment Exercise (RAE). The definition of physics course we have used is HESA's (and UCAS's), and IoP may have drawn the category somewhat differently. We suspect also, however, that the IoP may have failed to take into account a subject re-classification in 2002 which boosted physics numbers by bringing in combinations with subjects like education (as in undergraduate education degrees). But we can confirm that many universities have indeed closed their physics departments.

1.5 In Chapter 5, we consider in depth the associations between school background and gender to examine the claim that physics is being sustained as a school subject in the independent sector. We find that students in independent schools are both more likely to take physics at A-level and read physics at university than students in the maintained sector, particularly among girls. But grammar schools are more like independent than other maintained schools in these respects, perhaps because both are selective.

1.6 In Chapter 6 we turn to the subject choices of students entering university with A-level physics. Less than ten per cent take physics itself, so we ask where are the other 90 per cent or more going? We also explore whether there have been changes over time and whether there are gender differences.

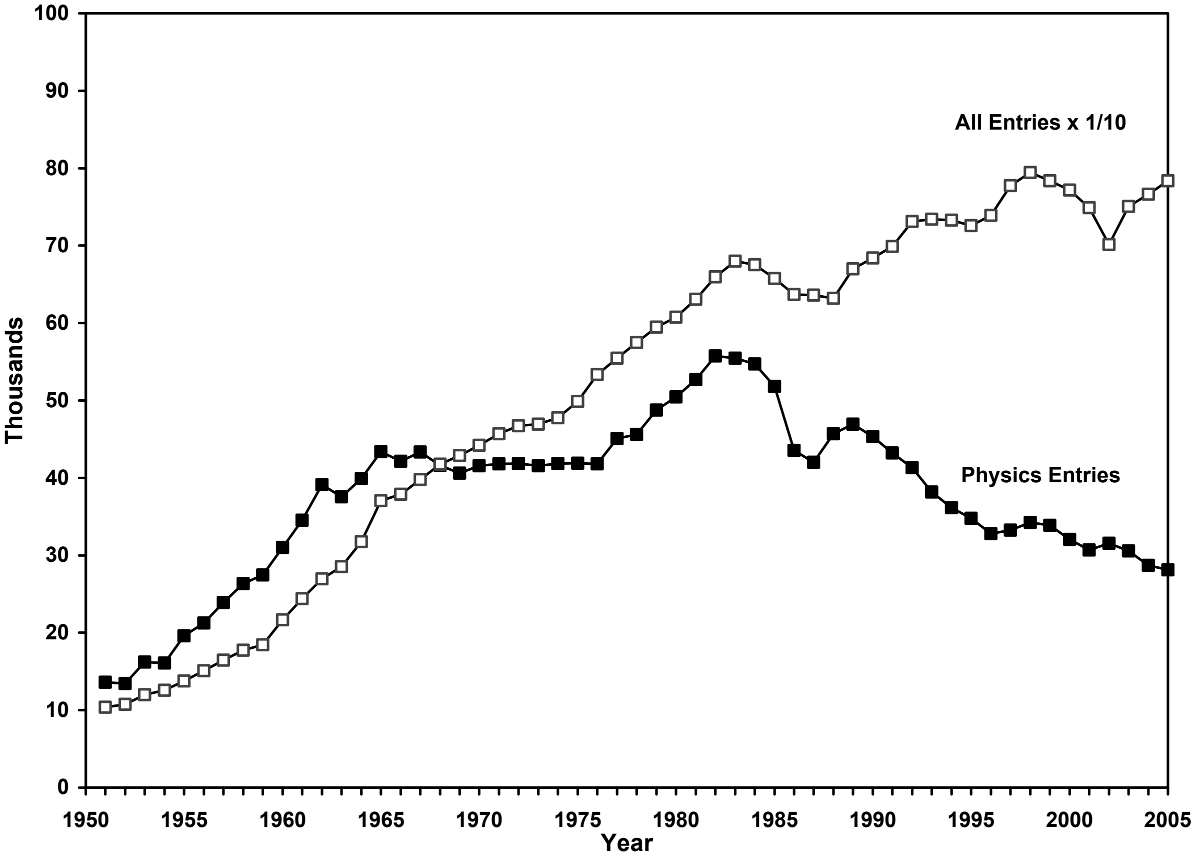
1.7 Since it appears that universities have been struggling to fill their physics places, in Chapter 7 we look at the impact on degree output, in particular on degree classification. We also chart the destinations of the graduates into further study and employment. In Chapter 8 we focus on those physics graduates going into teaching – how many compared with other science graduates, their degree classes, what they are training to teach, how many successfully complete and how many of the successful completers actually take teaching posts.

1.8 In the concluding chapter we draw the threads together pinpointing the main features of the numerical picture, offering some interpretations and relating the findings to current government policy.

2. A-Levels

2.1 Unlike total A-level entries, those in physics have not continued to increase year by year. There were fewer A-level physics entries in 2005 than in 1960, whereas numbers overall have nearly quadrupled. Chart 2.1 shows the trends since the inception of A-levels in 1951, with the entry total divided by ten to fit on the scale. It shows that from 1951 through to 1982 both physics and total entries rose, but since then while entries overall have gone up in most years, those in physics have fallen sharply. From a peak in 1982 of 55,728, they were down to almost half that figure in 2005, 28,119. Why the different trajectories?

Chart 2.1: A Level Physics Entries Compared to All Entries



Sources: Education in England and Wales, Report and Statistics 1951-1977; Statistics of Education School Leavers CSE and GCSE 1978-84, England, Inter-Awarding Body Statistics for England, Wales and Northern Ireland, Joint Council for Qualifications 1985-present.

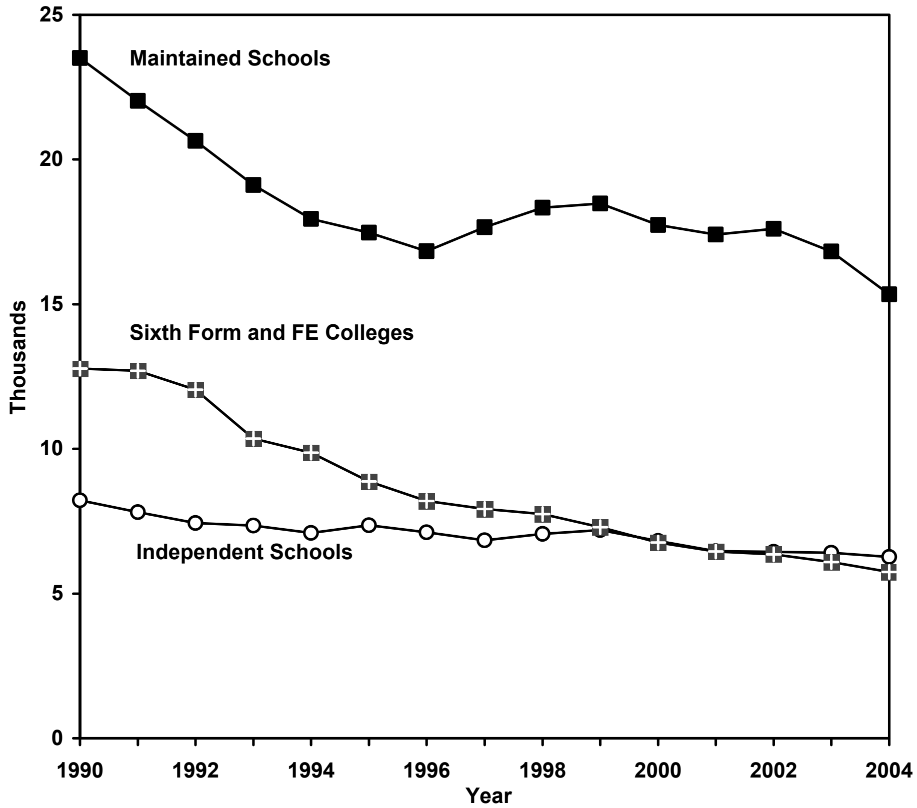
2.2 A-level physics entries and entries overall went up more or less proportionally from 1951 to 1965 (bearing in mind 'all entries' divided by ten), but then while total entries continued rise, physics entries stalled. The major change in the educational landscape in 1965 was the Crossland Circular to local authorities directing them to implement a comprehensive system of secondary education (DES, 1965). This opened up the opportunity for many more students to take A-levels and is likely to have contributed to the continued growth overall. But it is difficult to see why physics should have been adversely affected by the disbanding of the grammar schools unless the clustering of very able students should be important to its success. Whatever the reason, A-level physics growth resumed briefly in 1975.

2.3 But in 1983 both physics and total A-level entries began to fall, physics more steeply. This reversal can be traced to a steep drop in the number of 18-year-olds which went down by about a third over the period to 1995, consequent upon the end of the post-war baby boom in 1964. Entries overall, however, did not long continue their downward path. The merging of O-level and the Certificate of Secondary Education in 1988 proved to be a powerful countervailing influence as far as total entries was concerned. For physics, however, not only was the decline steeper, but the respite around the time of GCSEs and the reorganisation of the examination boards (which affected the compilation of statistics) was short-lived. Since 1989 the trend in physics has been inexorably downwards. Total entries also dipped from 1998, but since changes to A-level effective from 2002 they have begun to pick up again. Physics, however, has not shared in this revival.

School Background

2.4 Although A-level physics entries have fallen substantially since 1990 this has not occurred uniformly across the school types. Chart 2.2 shows that while take-up fell sharply in maintained schools and colleges from 1990-1996, independent schools were less affected.

Chart 2.2: Physics A-Level Entries by School and College Type



Source: Inter-Awarding Body Statistics, Joint Council for Qualifications.

2.5 Chart 2.3 shows the data in more detail. Among maintained schools, it is clear that the fall in A-level physics entries in the period 1990-2004 has been mainly in the comprehensive schools and the few remaining secondary moderns. Grammar schools, in fact, suffered the smallest decline (about a fifth), less even than the independent schools (down by almost a quarter). The steepest reduction of all has been in the FE Colleges where physics entries have fallen by two-thirds since 1990. The drop in sixth form colleges is of the same order as that in comprehensive schools.

Chart 2.3: A-Level Physics Entries by Institution Type[1]

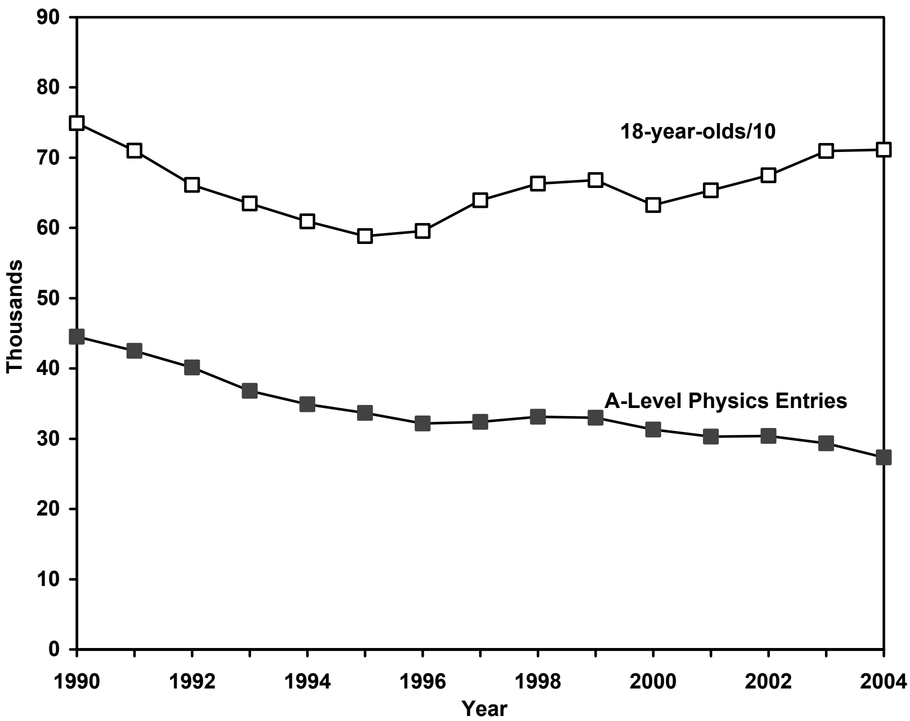
Institution	Physics A-Level Entries 1990	2004	%Change
Comprehensive	17,819	10,823	-39.3
Grammar	5,470	4,365	-20.2
Secondary Modern	271	152	-43.9
Independent	8,217	6,270	-23.7
Sixth Form College	5,820	3,543	-39.1
FE College	6,956	2,202	-68.3
Total[2]	45,384	27,760	-38.8

1. Inter-Board Statistics for England, Wales and Northern Ireland.
2. Does not include a small number of entries from 'other' centres.

Demography

2.6 In the next chapter we explore whether the trends in the different types of school and college can be traced back to changes in the examinations at age 16. But it is evident from Chart 2.4 that the decline in school physics is not solely a function of demographic changes.

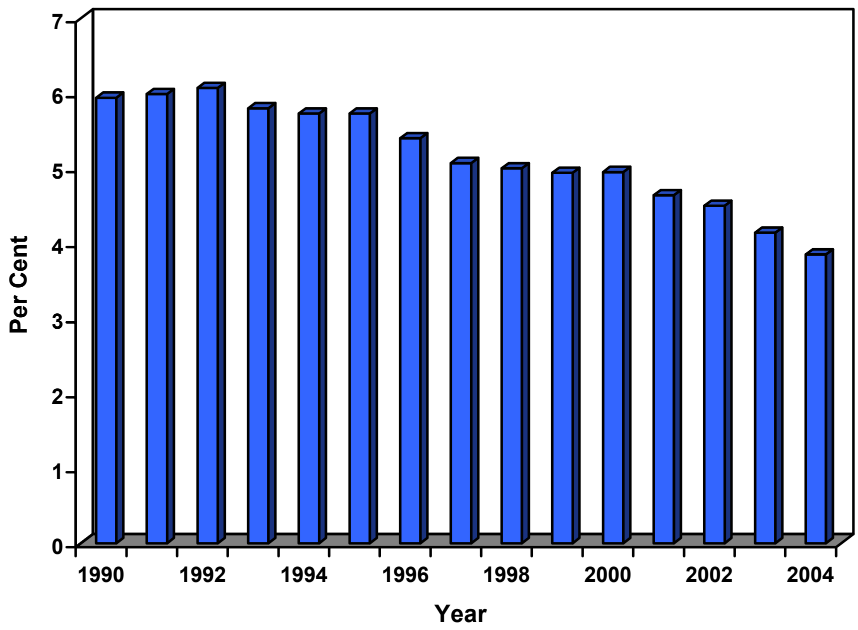
Chart 2.4: Physics A-Level Entries and Population Trend



1. General Register office mid-year estimates of population of 18-years in England, Wales and Northern Ireland divided by 10 to sit comfortably on same scale as A-level physics entries.
2. A-level entries from maintained schools, independent schools, sixth form colleges, tertiary colleges and FE colleges in England, Wales and Northern Ireland compiled from the Inter-Awarding Body Statistics.

2.7 While the decrease in A-level physics entries does follow the fall in the number of 18-year-olds from 1990 to 1995, thereafter physics continues to drop even though the number of 18-year-olds increases. Chart 2.5 expresses the trend in A-level entries as a percentage of the population of 18-year-olds in England, Wales and Northern Ireland.

Chart 2.5: A-Level Physics as Percentage of Age Group



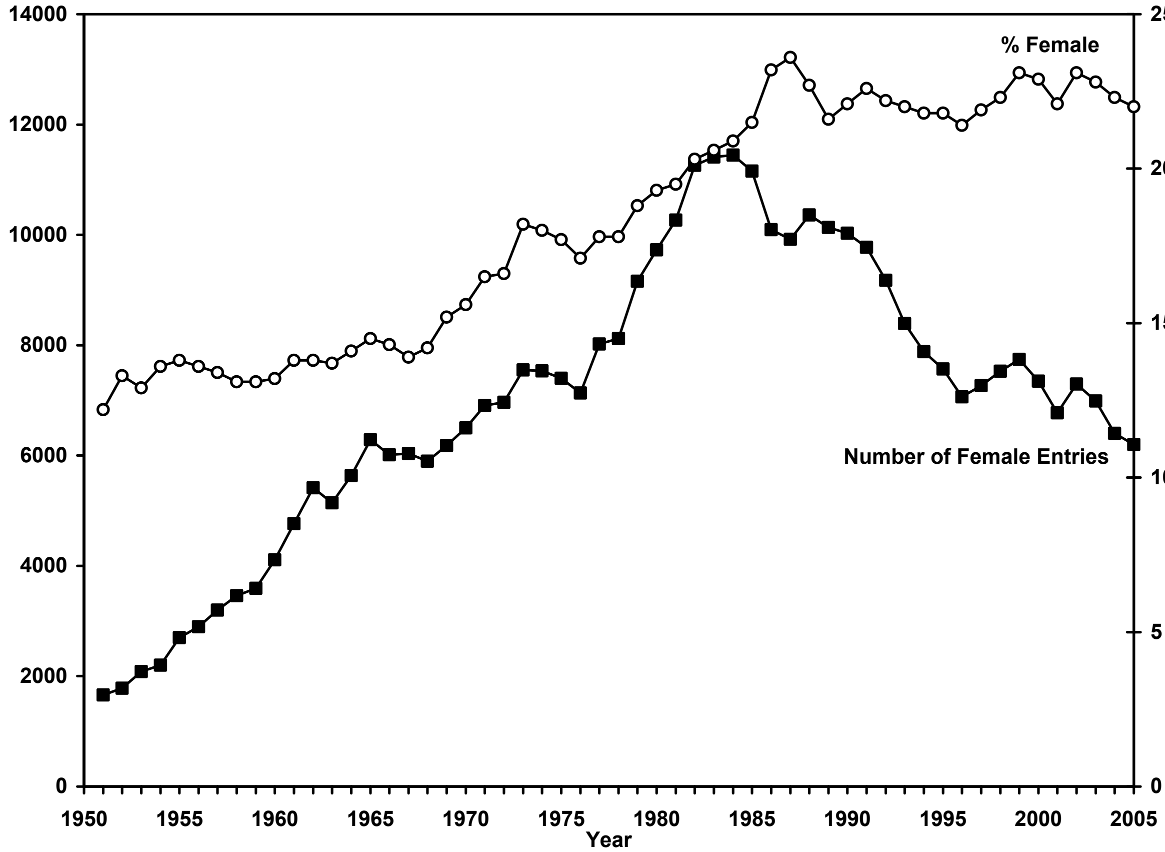
Sources: Percentage of 18-year-old population taking A-level physics. Population statistics for England and Wales from Government Actuaries Department (GAD) and for Northern Ireland from the Northern Ireland Statistics Research Agency (NISRA). A-level entries from maintained schools, independent schools, sixth form colleges, tertiary colleges and FE colleges in England, Wales and Northern Ireland from Inter-Awarding Body Statistics.

2.8 It shows a slight rise to the equivalent of just over 6 per cent of 18-year-olds taking A-level physics in 1992 (not all the entrants are 18, but the great majority are), since when there has been a continual decline so that by 2004 the percentage had fallen to 3.85. Even if one takes the view that A-level physics is accessible to only part of the ability spectrum, Chart 2.5 shows that, by comparison with 1992, potentially over half as many again would seem capable of studying the subject as are doing so now.

Gender

2.9 Take-up of A-level physics by male and female sixth formers has declined to the same extent in recent years. Chart 2.6 shows that over the past two decades the proportion of A-level entries from girls has centred on 22.4 per cent, with variation of barely one percentage point either way. In 1986 the proportion was 23.2 per cent, slipping back to 21.4 per cent in 1996, and recovering slightly to 22.0 per cent in 2005. This is disappointing for those who saw the introduction of compulsory science to age 16 in the national curriculum and a double-award science GCSE as a means to closing the gender gap. Before these changes, the proportion of female entries to A-level physics had nearly doubled from the 12.2 per cent in 1951. It seems that girls had already had the opportunity to discover whether they liked physics and were good at it, and generally just over a quarter compared with the boys (hence just over a fifth of the overall physics entries) found that physics was for them. The factors leading to the downturn in physics A-level seem to have affected both sexes similarly. We can infer from the higher percentages studying physics in the early nineties that there are girls capable of taking A-level physics who are not doing so now. The gender imbalance in physics contrasts markedly with A-level entries overall, 54.2 per cent of which came from female students in 2005.

Chart 2.6: A-Level Physics Entries by Gender

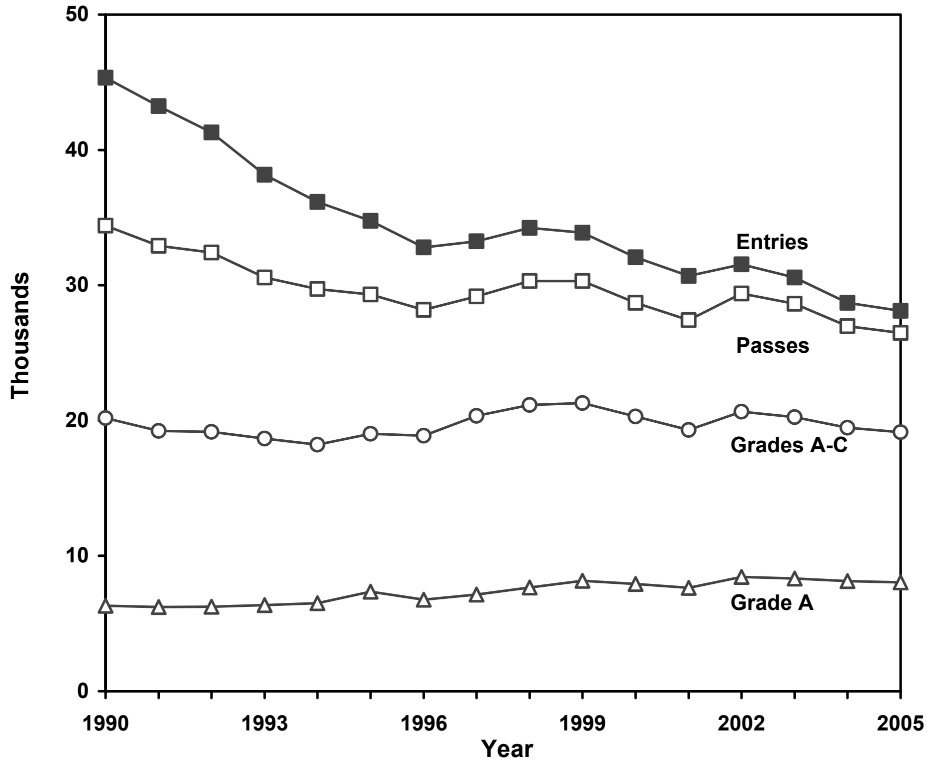


Sources: Education in England and Wales, Report and Statistics 1951-1977; Statistics of Education School Leavers CSE and GCSE 1978-84, England, Inter-Awarding Body Statistics for England, Wales and Northern Ireland, Joint Council for Qualifications 1985-present.

Passes and Grades

2.10 The steep decline in A-level physics entries has been compensated for to a large extent by the increasing pass rate. This is brought out in Chart 2.7 which shows entries since 1990, together with passes, grades A-C and grade A. Although A-level physics entries have fallen by 38.0 per cent since 1990, passes are down by much less, 23.0 per cent. Such has been the improvement in grades that the number of A grades awarded has actually increased from 6,323 in 1990 to 8,042 in 2005 (up by 27.2 per cent). In spite of entries falling by 17,215 over the 16 years, passes at grades A-C were down by only just over a thousand. This points to either considerable grade inflation or more of the weaker students selecting themselves out before completion.

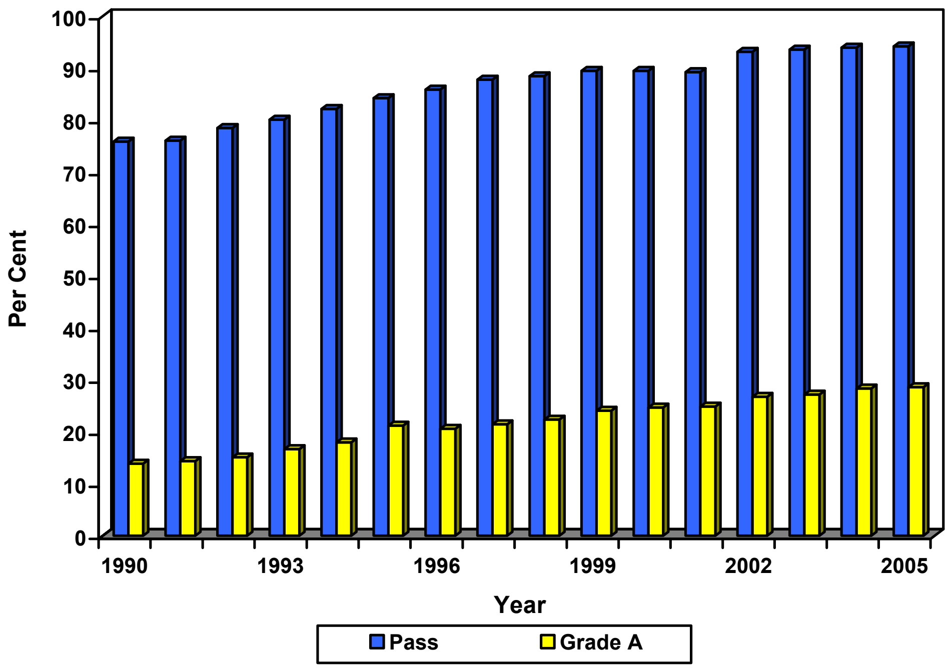
Chart 2.7: A-Level Physics Passes and Grades



Source: Inter-Awarding Body Statistics, Joint Council for Qualifications.

2.11 The substantial increase in the pass rate is brought out in Chart 2.8. Between 1990 and 2005 the pass rate went up year by year with a step change in 2002 following modularisation and the Advanced Subsidiary becoming available as a half-way-house to Advanced Level.

Chart 2.8: A-Level Physics Pass Rates



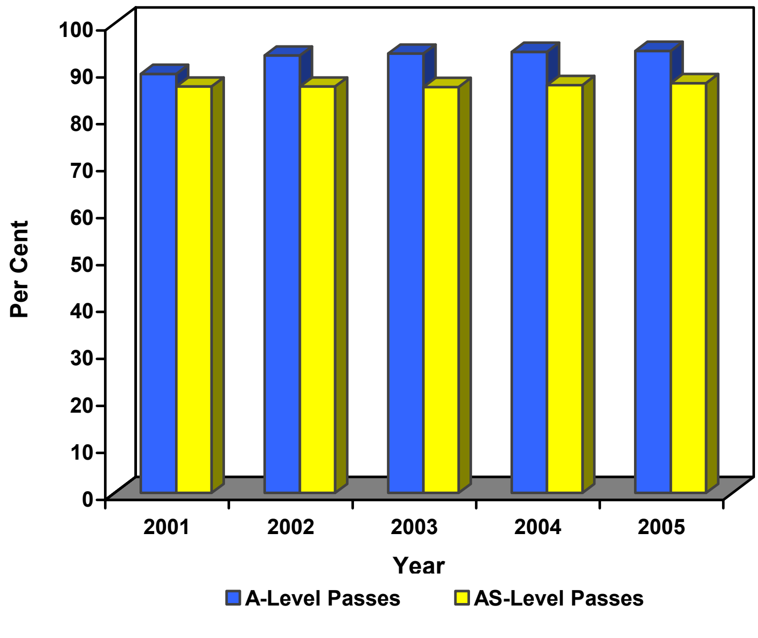
Source: Inter-Awarding Body Statistics, Joint Council for Qualifications.

2.12 The magnitude of the change over 16 years is as startling in physics as in other subjects. Whereas in 1990 the pass rate was 75.9 per cent, by 2005 it had reached 94.2 per cent. During that time the percentage of A grades more than doubled – from 13.9 to 28.6. But modularisation and AS had the greatest impact with, in a single year, the pass rate leaping from 89.3 per cent in 2001 to 93.2 per cent in 2002, while A grades went up from 24.9 to 26.8 per cent.

AS Results

2.13 The AS examination was introduced as a stepping stone to A-levels in 2001 and will have affected individual decisions from 2002 onwards as to which A-levels to pursue. In Chart 2.9, AS physics results are compared with those at A-level. Over the five years the AS physics pass rate has gone up by only 0.7 per cent, compared with the 4.9 per cent at A-level. The gap in 2001 when AS will not have influenced A-level choices was only 2.7 per cent, but it has now settled at approaching three times that figure. This can be interpreted as showing that AS results are being used as a filter to A-level, and some weaker candidates are not proceeding after the early warning which the one-year examination gives. Others may have found that A-level physics was not for them and instead of having to soldier on, as they would have had to in the past if they wanted a qualification, they are able to complete a one-year award. At least part of the increasing pass rate at A-level itself can be explained in these terms. But it is also true that some may have been taking the AS in its own right as a supplementary subject.

Chart 2.9: Physics A-Level and AS Passes



1. Inter-Awarding Body Statistics, Joint Council for Qualifications.

Resumé

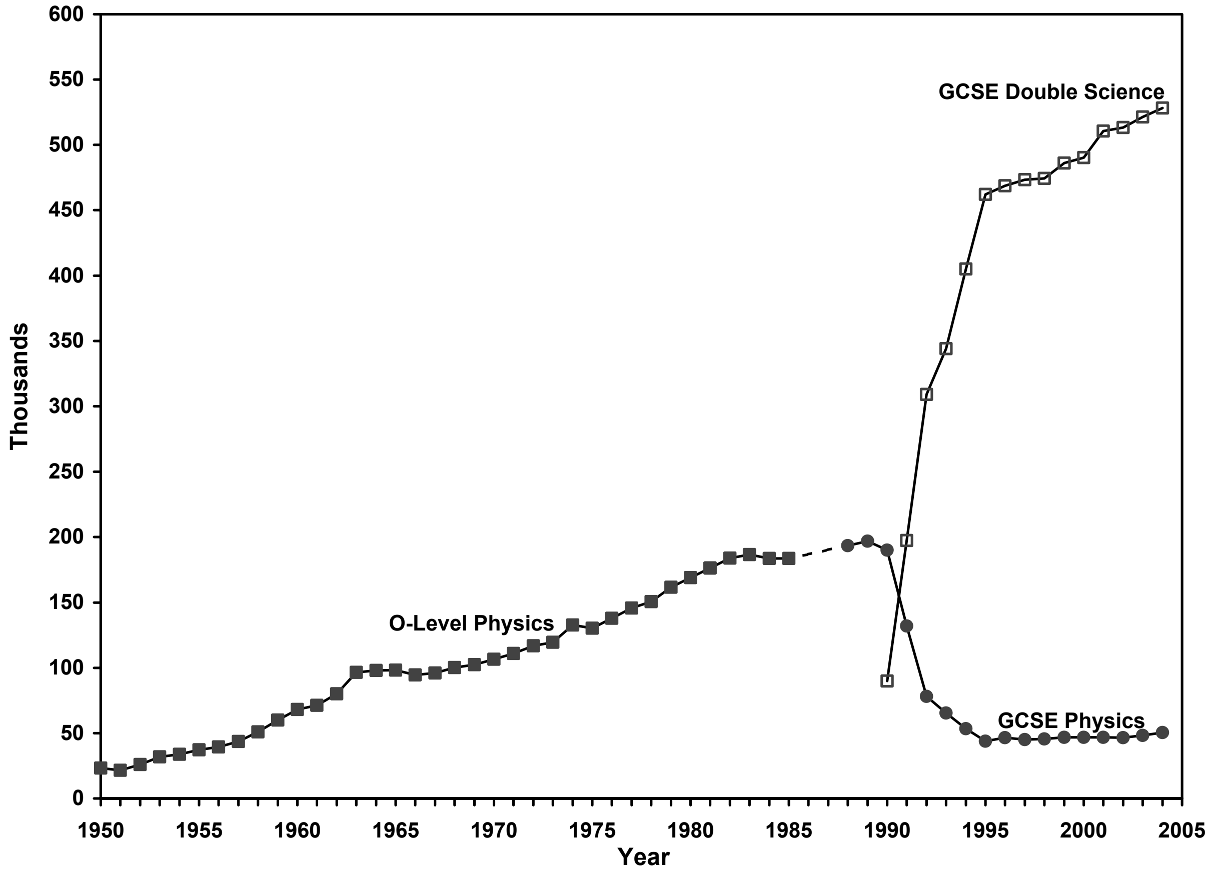
2.14 Entries to A-level physics have been falling sharply. Since 1990 they have dropped by 35.0 per cent while A-level entries overall have risen by 12.1 per cent. The rate of decline averaged 3.5 per cent per year between 1990 and 1996 compared with an annual average loss of 1.4 per cent since. The drop in the earlier period occurred mainly in comprehensive schools, sixth form and further education colleges, with grammar and independent schools less affected. The decrease will have been consequent in part on the reduction in the population of 18-year-olds, but it is not solely due to this since from 1990 the percentage of the 18-year-old population taking A-level physics has fallen from 5.9 per cent to 3.9 per cent. Both sexes have been similarly affected with the proportion of female A-level entries in physics centring on 22.4 per cent (compared with their overall percentage of 54.2).

2.15 Grades in A-level physics have risen as in other subjects. Since 1990 the pass rate in A-level physics has gone up from 73.9 per cent to 96.0 per cent, so while entries fell by 17,215, passes were down by less than half that, 7,922. The number of A grades awarded has, in fact, increased by 1,719 (27.2 per cent). Entries are higher and pass rates are lower at AS suggesting that those with the poorer performance in the one-year examination tend not to proceed to A-level itself.

3. O Level and GCSE

3.1 The major change in the science examinations at age 16 came with the introduction of a double-weighted science GCSE following the designation of 'science' as the subject in the 1988 National Curriculum. The courses that the double award defined were intended to be a balance between physics, chemistry and biology accommodating the three subjects in a two-subject slot on the timetable. The original intention had been that this should replace the three separate science awards, but protests from the independent sector, which was not bound by the national curriculum, led to the examinations in physics, biology and chemistry being retained. Representations from some of the leading maintained schools also won a concession from the Conservative government of the time that maintained schools could also enter pupils for the separate sciences providing they entered the pupils concerned for all three (thereby seeking to ensure that national curriculum science continued to be taught in a balanced fashion).

Chart 3.1: Trends in O-Level/GCSE Physics[1]



1. England and Wales to 1978, England only 1979- 88, England Wales and Northern Ireland 1989 to present; double award entries expressed as students ie actual awards halved.

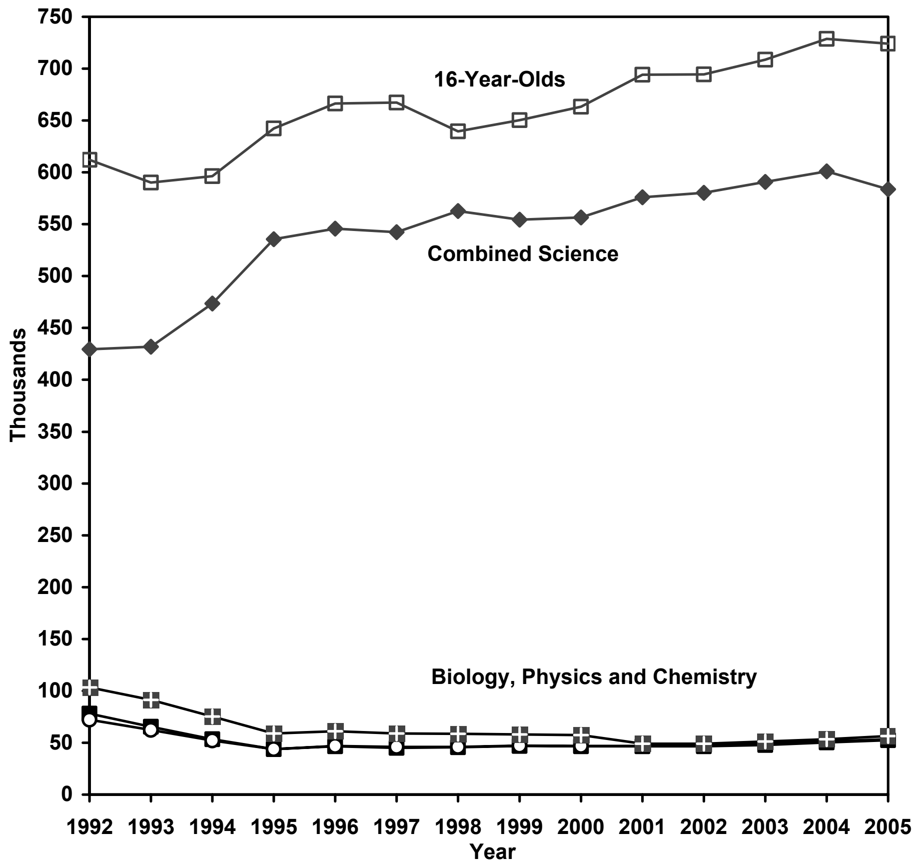
Sources: Report and Statistics of Public Examinations for England and Wales, 1950-78; Statistics of Education School Leavers CSE and GCSE, 1979-87, Inter-Awarding Body Statistics, Joint Council for Qualifications, 1988 onwards.

3.2 The national curriculum and contingent examination reform have had a major impact on school science studies. In Chart 3.1 we draw on different data sets, but trends clearly emerge even though the geographical coverage is somewhat different (with England comprising at least 90 per cent of the population in each set). It shows that the take-up of O-level physics increased steadily from just 23,240 in England and Wales in 1950 to 196,920 in England alone in 1989. But as the new requirements and regulations took effect GCSE physics entries dropped to a low of 43,839 (in England, Wales and Northern Ireland) from which there has been some halting recovery to 50,446 in 2004. In contrast, double award science entries have increased year by year. From 89,949 in 1990 they reached 528,210 in 2004. Given that many more pupils were taking physics to age 16 - albeit for most wrapped up in the double award - it might have been expected that the numbers taking the subject at A-level would have seen substantial increases and the gender gap would have been narrowed. In fact, neither has occurred. As we saw in Chapter 2, physics A-level entries have actually fallen and the gender balance has remained much the same.

Demography

3.3 Comparing combined science entries (single and double award published together till 1999) with the number of 16-year-olds as in Chart 3.2 shows that once GCSE science became established the increase in entries more or less matches the number of 16-year-olds. The provisional results for 2005 indicate for the first time an apparent fall in double-award science entries.

Chart 3.2: GCSE Separate Sciences



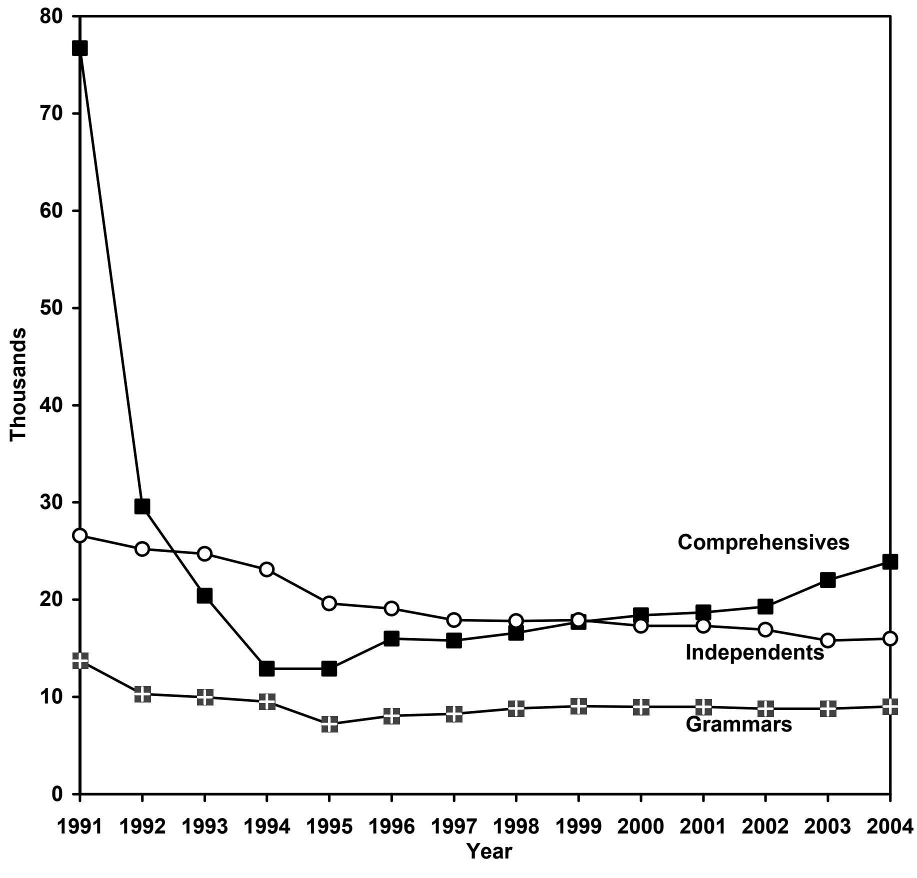
Source: National Provisional Results for GCSE published in August each year by the Joint Council for GCSE/General Qualifications. Entries to 1999 also include the entries for the single award since they were rolled up into the category 'science'.

3.4 Chart 3.2 also shows an effect of the requirement that maintained schools can only offer the separate sciences when the pupils are entered for all three. Physics, chemistry and biology, after some initial adjustment, run together all giving indications of a small recent rise.

School Type

3.5 In Chart 3.3 we examine the take-up of GCSE physics by school/college type. It has held up to the greatest extent in the independent schools (which remain free to offer any combination of the separate sciences) and the grammars (where they must offer all three). Significantly these are the two school types where A-level entries have fallen least. This could be causal with GCSE physics providing a better platform for A-level physics than GCSE science. But it is also possible that schools which offer GCSE physics are both strong in the subject and attract better qualified teachers. Or again, the grammar schools and most independent schools are selective with proportionally more pupils with the ability and interest to do physics.

Chart 3.3: GCSE Physics Entries by School Type[1]



1. Does not include entrants from secondary modern schools, sixth form and FE colleges and other centres which in total in 2004 amounted to just 1,460

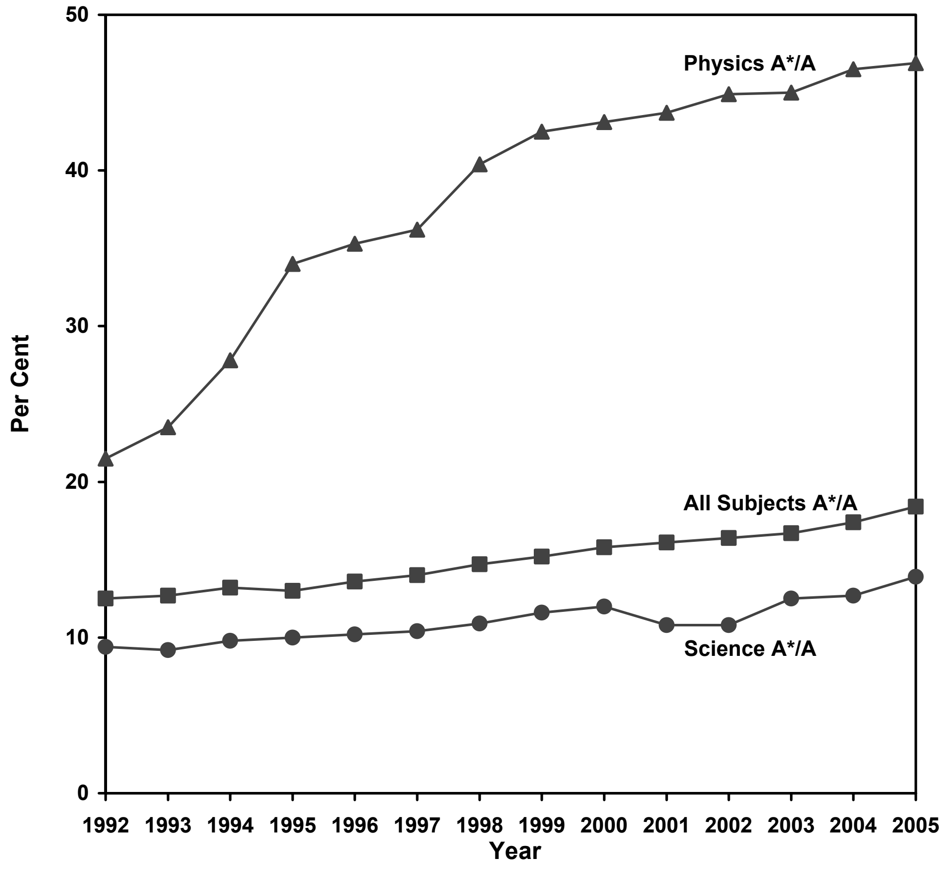
Source: Inter-Awarding Body Statistics, Joint Council for Qualifications.

3.6 Physics GCSE entries have fallen even in grammar schools (by 34.3 per cent) and independent schools (by 39.6 per cent) since 1991. The trajectories have, however, been somewhat different. In grammars, as the graph shows, the fall occurred mainly during the period of adjustment following the introduction of the combined science GCSEs, with entries almost halving to 1995, since when following a modest move upwards they have remained at more or less the same level. In the case of the independent schools there has been a steady drift downwards.

3.7 Chart 3.3 also brings out the sharp drop in GCSE physics entries in comprehensive schools, falling from 76,700 in 1991 to 12,900 in 1994 as schools switched to the combined science GCSEs. But since 1995 there has been an upturn, with the numbers recovering to 23,900 in 2004. A possible explanation is the emergence of specialist science schools. Re-analysing the data from our 2005 survey (Smithers and Robinson, 2005) we found, on average, about double the number of GCSE physics students in specialist schools as schools without a specialism – 16.5 against 7.8 (significant beyond $P < 0.001$). But the highest numbers were in the language schools (average, 31.2), with the science schools coming only fourth (average, 19.4).

3.8 We similarly found in our earlier analysis (Smithers and Robinson, 2005) that the science teachers in language schools had the highest qualifications in physics. It is likely, therefore, that at this early stage in their development the performance of specialist schools has more to do with factors other than their designated specialism such as history, ethos, location and funding. We are, in any case, in the survey dealing with only one point in time so no causal inferences can be drawn, but the impact of the establishment of science schools on the take-up of the sciences should be investigated further.

Chart 3.4: Trends in GCSE Grades



Source: National Provisional Results for GCSE published in August each year by the Joint Council for GCSE/General Qualifications. Entries to 1999 also include the entries for the single award since they were rolled up into the category 'science'

Grades

3.9 It was speculated that there is a connection between GCSE physics take-up and A-level physics entries because it was pupils with the ability to do physics who were taking the specialist GCSE. This receives some support from the trends in A grades at GCSE shown in Chart 3.4. In the 2005 provisional results, approaching half the entrants for GCSE physics (46.9 per cent) obtained a grade A* or A. The proportion has more than doubled since 1992 (21.5 per cent) with the increases occurring particularly in the period to 1995 when entries were falling. The proportion obtaining A*/A grades in physics is more than three times that in double-award science (13.9 per cent) and indeed is considerably in excess of the percentage overall (18.4 per cent). Assuming some consistency of standards across subjects, those taking GCSE physics emerge as a high attaining group. Relative progression to A-level also suggests that the physics GCSE is a better platform for the A-level than are the science GCSEs. It is an open question whether there are students who have not opted for A-level physics, but who would have done so had they had opportunity of taking GCSE physics.

Resumé

3.10 Designating ‘science’ as the subject in the national curriculum and the associated changes in GCSE examinations has had a considerable impact on school science studies. There is no one consistent database available, but general trends nevertheless emerge. Take up during the lifetime of O-level increased by nearly eightfold from 23,200 in England and Wales in 1950 to 196,920 in England alone in 1989. But as the national curriculum and new examinations took effect, in its guise as a GCSE, physics fell to a low of less than a quarter of the peak (43,839 in 1995 in England Wales and Northern Ireland) although there has been a recent upturn.

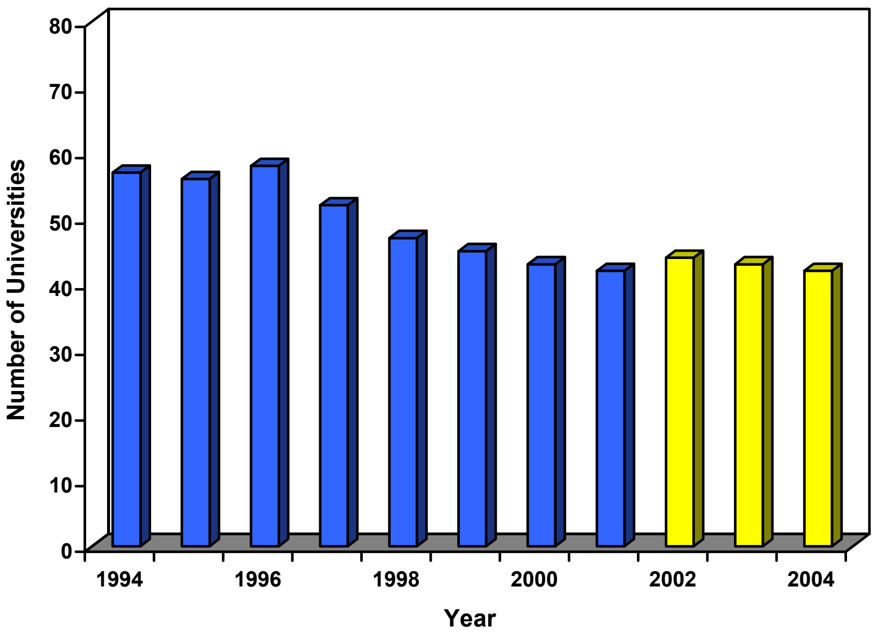
3.11 Meanwhile the double award science GCSE, intended to represent a balanced combination of physics, chemistry and biology, surged in the years immediately after its introduction from 89,949 entries in 1990 to reach 538,210 in 2004. Thus, while many more pupils have the opportunity to study some physics as part of science to age 16, fewer are able to specialise in the subject. This growth in science studies to age 16 has not led to an increase in the A-level physics take-up – rather the reverse. Independent and grammar schools have been more likely to retain physics as a separate subject than comprehensive schools. Students taking GCSE physics are three times more likely to obtain an A*/A grade than those taking combined science – in 2005, 46.9 per cent against 13.9 per cent – indicating that they are a high attaining group.

4. University Places and Admissions

4.1 Another symptom of the apparent decline of physics has been the closure in recent years of a number of university departments. This could be a consequence of falling demand. As we saw in Chapter 2, A-level take-up has been in steep decline, though with passes falling much less than entries. But it could also be the result of other pressures. In order to chart the trends in university physics, we have commissioned special analyses from HESA and UCAS.

4.2 HESA was able to provide data on first-year full-time UK-domiciled physics students for the years 1994 to 2004 (though with some redefinition of what counted as physics from 2002 onwards – distinguished by the different shading in the first three charts). Chart 4.1 shows that the number of departments offering physics with first-year intakes of 10 or more fell from 57 in 1994 to 42 in 2004, even with the two extra departments brought in by the inclusion of physics combinations from 2002. If we had included all departments shown as having any first-year physics students at all at any time during the eleven years, this would have come to 78, of which only 54 were extant in 2004.

Chart 4.1: UK Universities Offering Physics Degrees[1]



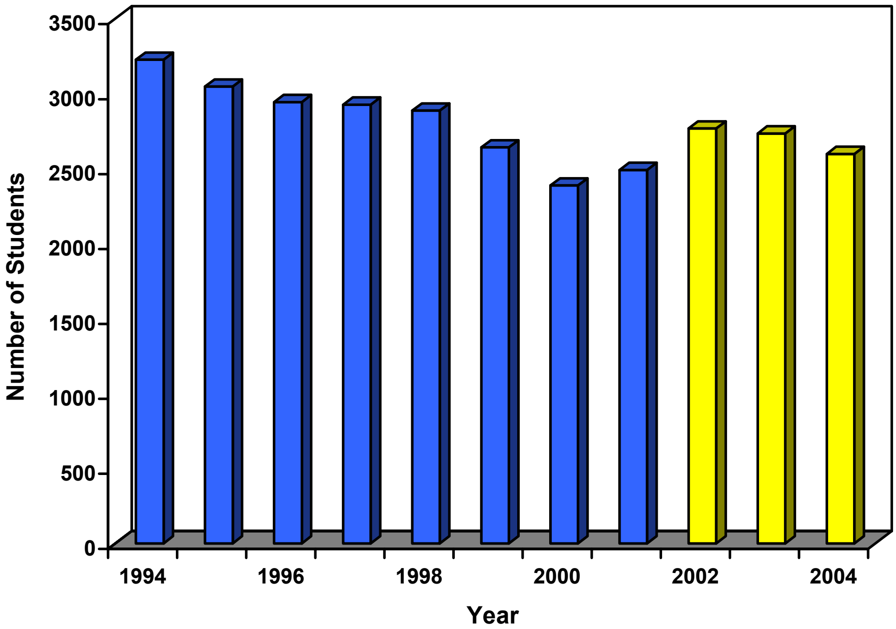
1. With ten or more first-year, full-time UK-domiciled students. Re-classification of subjects from 2002 bringing in those studying physics in combination, including as part of a B.Ed degree, temporarily boosted the number of universities.

Source: Specially commissioned from Higher Education Statistics Agency, 2006.

4.3 The universities closing their departments were mainly, but not exclusively former polytechnics. Among the pre-1992 universities, Essex, East Anglia and Brunel all withdrew. Three universities with a physics intake of 75 or more in 1994-95 (Portsmouth, De Montfort and Glasgow Caledonian) no longer offer degrees in the subject, so some large players have left the field. The re-classification in 2002 to include combinations involving physics brought in departments offering physics as part of education degrees, as well as others. But Chart 4.1 shows that following the re-basing the downward trend continued.

4.4 Student numbers (including those in departments with an intake of fewer than 10) have also been falling, though this is partly obscured by the re-classification. Chart 4.2 shows that keeping to a consistent definition the number of home-domiciled first-year full-time physics degree students fell from 3,227 in 1994-95 to 2,492 in 2001-02, down by 22.8 per cent. On the new classification†, the fall was from 2,768.7 in 2002-03 to 2,598.5 in 2004-05, a further decrease of 6.1 per cent.

Chart 4.2: First-Year Full-Time Home Physics Students[1]



1. Students reclassified from 2002 to include under physics all those studying the subject in combination with other subjects including education in B.Ed degrees.

Sources Specially commissioned from Higher Education Statistics Agency, 2006.

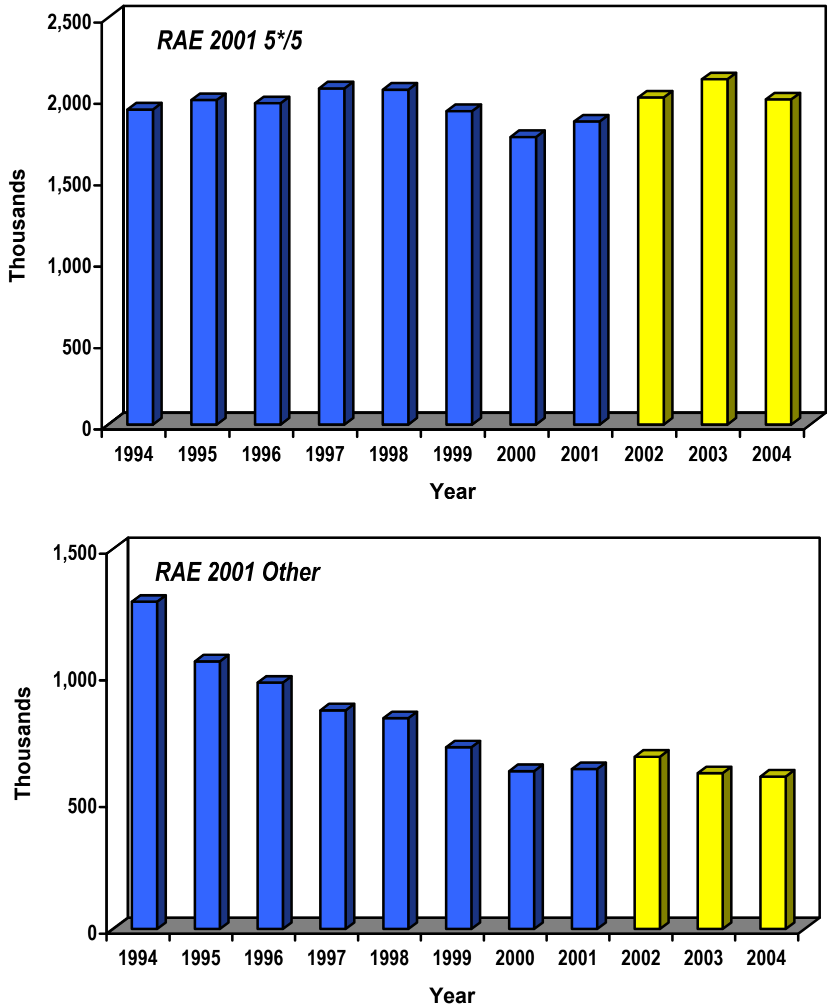
Research Rating

4.5 The universities vary considerably in their standing in physics. As an indicator, we have used the 2001 RAE ratings to divide the departments awarded 5* or 5 from the others. Chart 4.3 shows that their fate since 1994 has been very different. The 26 universities achieving the highest ratings in physics had a combined UK-domiciled intake of 1,935 in 1994 and 1,861 in 2001, down by 74 or 3.8 per cent. Following re-classification in 2002 the intake became 2088.7 and this dropped to 1996.9 in 2004, a further fall of 91.8 or 4.4 per cent. The trend even in the elite universities is, therefore, downward, but nowhere near as pronounced as elsewhere.

† On the new classification which includes combined studies there are part-students spending some of their time on physics and the rest elsewhere so the total is not necessarily a whole figure but is expressed to one decimal point.

4.6 In sharp contrast, however, was the fate of physics in the other 52 universities that at various times had had physics students since 1994. All but 28 had given up physics. Chart 4.3 shows that overall their physics intake halved from 1,292 in 1994-95 to 631 in 2001-02. Post-re-classification, in 2002, there was a further reduction from 680 to 601.6, or 11.5 per cent.

Chart 4.3: Physics Intakes by RAE Rating



1. Students reclassified from 2002 to include under physics all those studying the subject in combination with other subjects including education in B.Ed degrees.

Sources Student numbers from analyses specially commissioned from Higher Education Statistics Agency, 2006; RAE rating from Institute of Physics

4.7 The picture becomes even starker if we separate off the 13 departments which received a grade 4 in the 2001 RAE. In these universities the intake fell from 482 to 441 (8.5 per cent) from 1994 to 2001 and from 462.3 to 421.1 from 2002 to 2004 (8.9 per cent). This leaves 39 departments receiving a lower rating or no rating at all either because they did not enter or had closed the physics department before 2001. In these universities the physics intake fell by more than a quarter from 810 in 1994 to 190 in 2001, with a further reduction of 17.1 per cent from 217.7 in 2002 to 180.5 in 2004.

4.8 There has been, therefore, a concentration of students in the departments with the top research ratings. This has, however, not come about through increasing numbers, but rather lower losses. In the other departments, particularly those not achieving '4s', there have been sharp reductions to the point almost of disappearance. Of the 52 other universities with physics students in any of the eleven years, only 16 had an intake of ten or more physics students in 2004, including the ten that were 4-rated.

Countries and Regions

4.9 Chart 4.4 shows the distribution of universities with ten or more first-year full-time physics students by country and the English regions in 1994 and 2001, and Chart 4.5 the distribution of the students.

Chart 4.4: Universities by Region

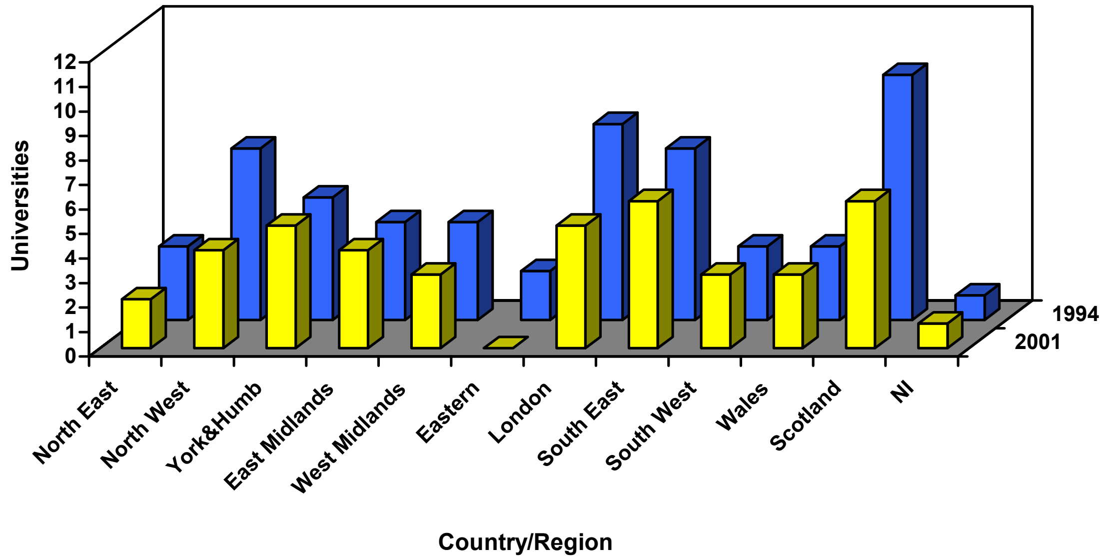
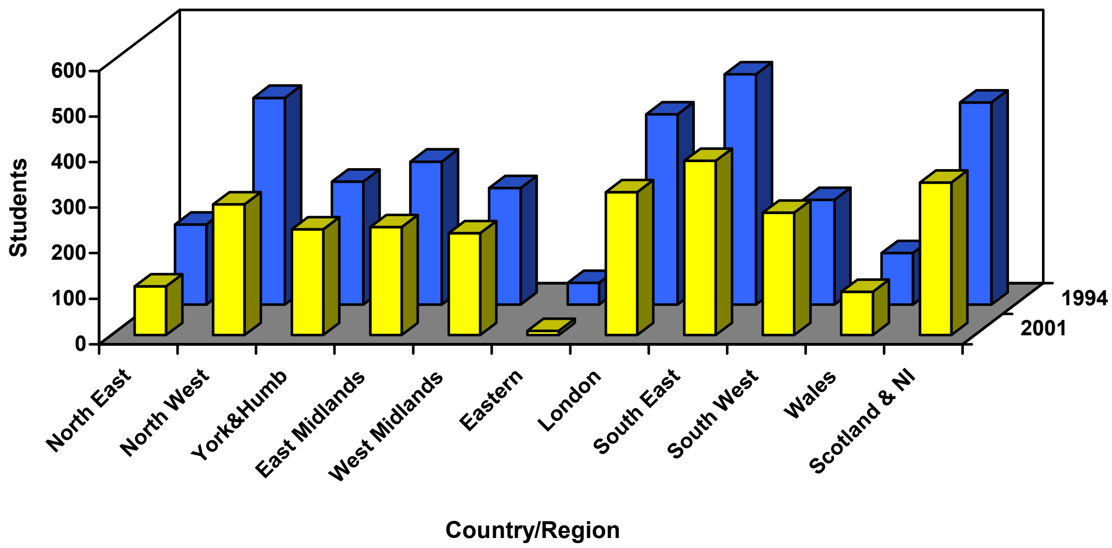


Chart 4.5: Students by Region

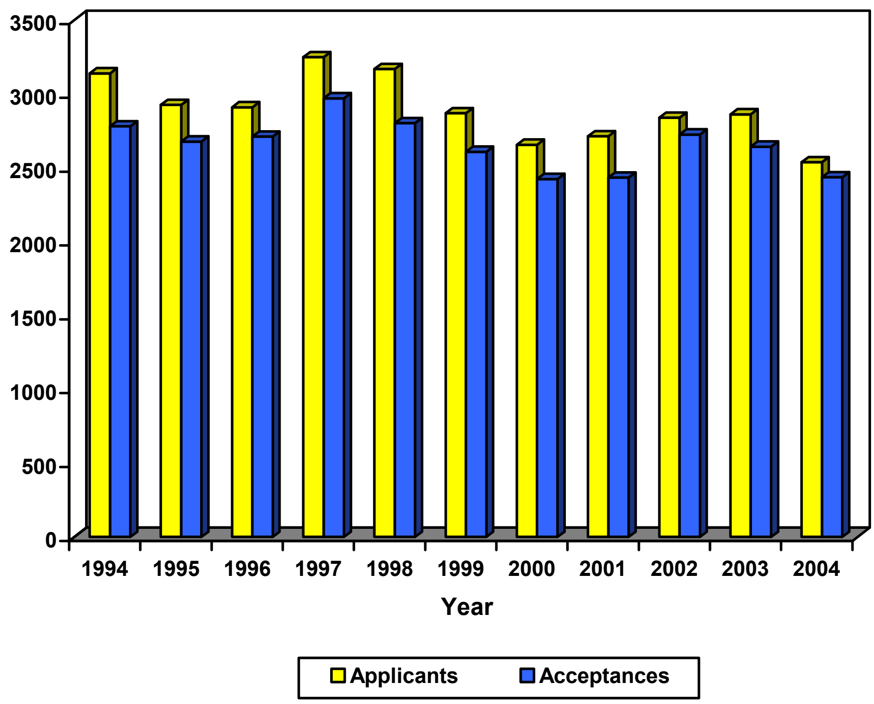


4.10 Scotland (4) suffered most losses followed by London (3) and the North West (3, even discounting the merger of the University of Manchester and UMIST). Following the closure of the physics departments at the University of East Anglia and the University of Essex, the Eastern region has been left without any.

4.11 The changes in the distribution of the student intake (into all departments including those with less than ten) between 1994 and 2001 follows that of the departments to a large extent. Chart 4.5 shows that the major losses occurred in the North West (165), Scotland and Northern Ireland (109), and London (104). However the correspondence is not exact. The South East which suffered a net loss of just one department was nevertheless 123 students down and the East Midlands retaining its departments admitted 77 fewer students. Only one region showed an increase. The three universities of the South West increased their intake by 39. The rank order correlation comes out at +0.683, significant at the five per cent level of significance. Thus departmental closures and subsequent numbers choosing to study physics in higher education are significantly related, but other factors such as reputation and funding are also involved.

4.12 The research assessments, as we have seen, appear to have had a major impact. As well as bearing on reputation, there will have been a direct effect on funding which is skewed heavily in favour of the 5*/5 departments. In universities not achieving a top rating for physics, this will have exacerbated the costs of already expensive provision leading some to withdraw from physics altogether and transfer the places to less expensive and more popular subjects such as sports science. In what has some characteristics of a market, it is to be expected that the weaker performers would be squeezed.

Chart 4.6: Applicants and Acceptances[1]



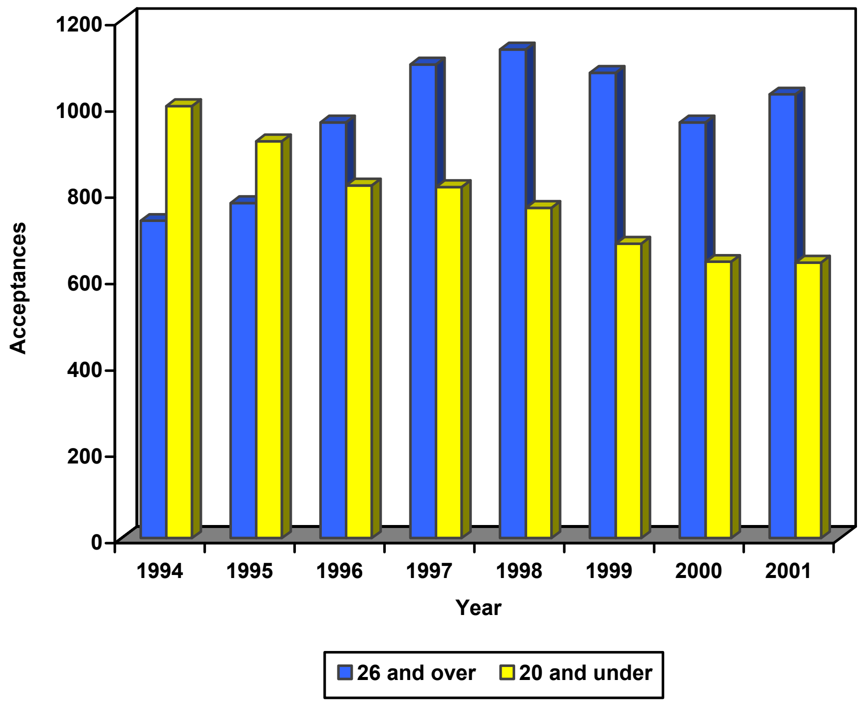
1. Home domiciled applicants to UK universities.
Source: UCAS.

Admissions

4.13 Demand has been falling, in part, due to fewer students obtaining A-level physics, the main entry qualification for physics degrees. During the period covered by UCAS statistics, although with variation from year to year, the reduction was 9.2 per cent. Chart 4.6 shows that this was exceeded by the drop in applications to university physics courses from 2,780 in 1994 to 2,433 in 2001 (12.4 per cent) and following re-basing from 2,725 in 2002 to 2,435 in 2004 (10.6 per cent). More of the applicants have been accepted, however. In 2004, 96.0 per cent of those applying were offered and accepted places compared with 88.6 per cent in 1994. Looking further back to 1986 the pass rate then was 79.2 per cent.

4.14 But the higher acceptance rate was not at the expense of A-level entry grades. Chart 4.7 shows that acceptances on lower A-level grades (equivalent to a B and two Cs) fell by 36.3 per cent from 1994 to 2001 (since when the new tariff system has made meaningful comparisons impossible). Over the same period acceptances on higher grades (the equivalent of at least an A and two Bs) have risen by 39.9 per cent though even this is below the peak in 1998 which saw an increase of 54 per cent above 1994.

Chart 4.7: A-level Points Score of Acceptances[1]



1. UK-domiciled acceptances to physics first-degree courses. A-levels scored on scale A=10 to E=2. From 2002 a new tariff system was introduced which is not comparable.

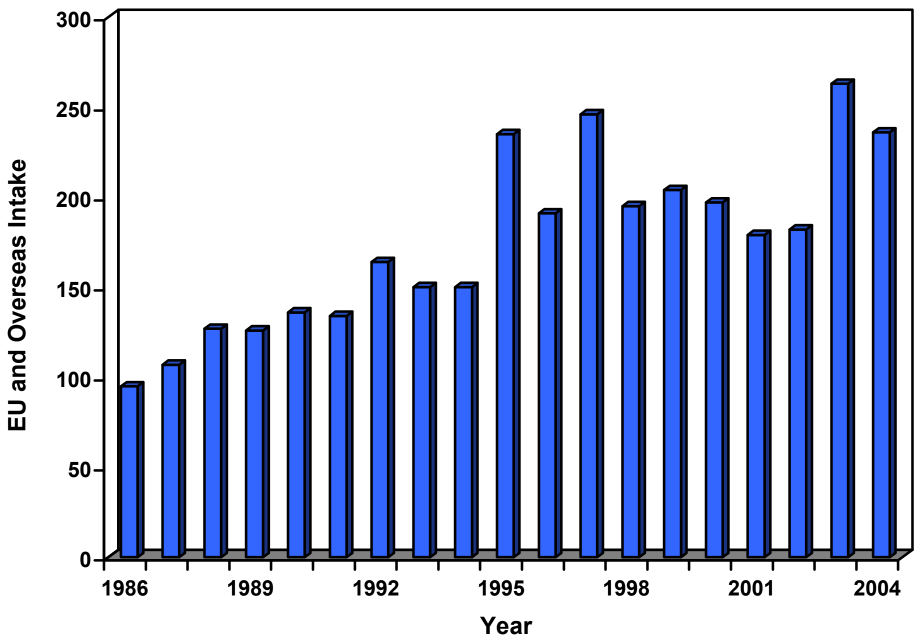
Source: UCAS.

4.15 Thus the picture on university admissions is complicated since physics departments are admitting better qualified students from a smaller pool of applicants accepting nearly all of them. We saw in Chapter 2 that although A-level physics entries have been falling the actual number of A-grades awarded has, in fact, risen and the number of A-C grades has been largely sustained. This can be interpreted as showing that, increasingly, weaker students are selecting themselves out of A-level physics and those with poorer grades are not applying to take physics degrees. Universities are, therefore, in a position to accept a higher proportion of applicants without lowering standards. There have been, however, fewer admissions overall, with the leading universities less affected than those with lower ratings. The net effect has been the concentration of the fewer students in fewer universities.

Overseas Students

4.16 So far we have been focusing on the intake of UK-domiciled students. Given that home demand has been falling, it is possible that to stay in business some physics departments have been recruiting more from Europe and overseas. Chart 4.6 shows acceptances from abroad since 1986. While the trend has generally been upwards the actual number of students is relatively small, even in 2004 only 8.8 per cent of the intake.

Chart 4.8: EU and Overseas Acceptances



1. EU and overseas students published in one category until 1994 and then separately, but so small relative to 'home' intake that they have been combined.

Sources: UCCA and PCAS to 1993, UCAS 1994 to present.

Resumé

4.17 Between 1994 and 2001 the number of UK universities admitting ten or more physics students went down from 57 to 42, with the loss of two further departments by 2004. First-degree physics students have become more concentrated in the 5*/5 research-rated departments. Over three-quarters of the first-year physics students in 2004 (76.8 per cent) were in the 26 top research departments. This clustering, however, has come about not by expansion, but by smaller decreases than in the other universities. Of the other 52 universities that have had some physics students since 1994, only 16 had an intake of ten or more in 2004 with 12 more having less than ten. Their combined intake fell from 1,292 students in

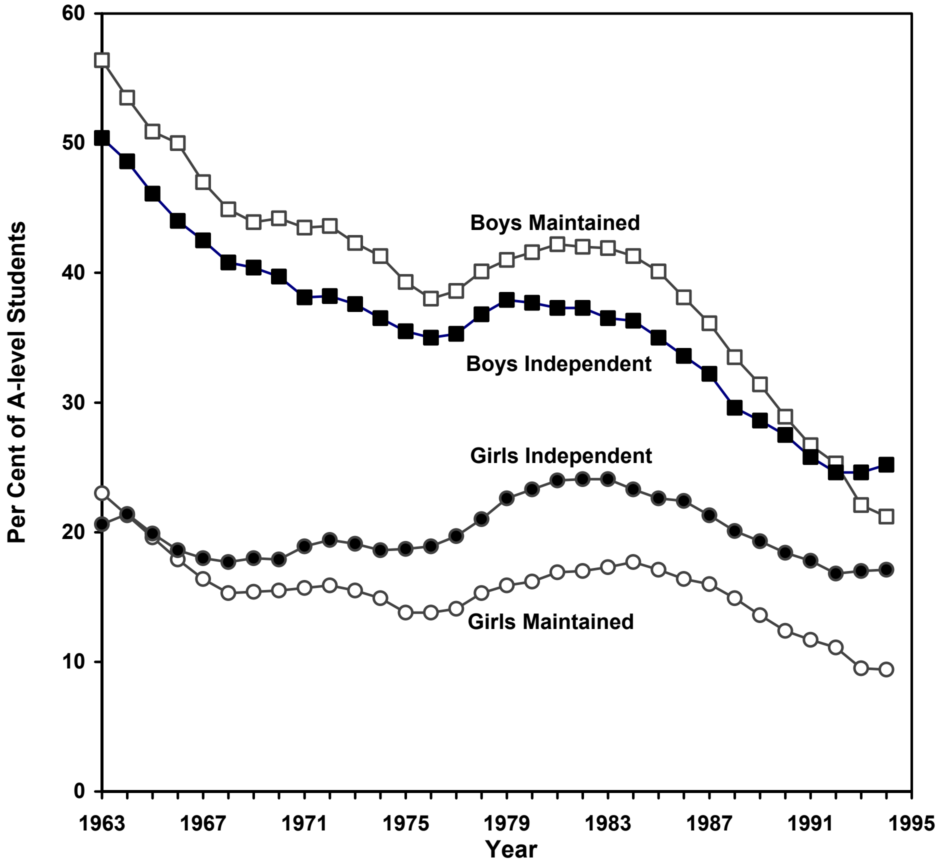
1994 to 601.6 in 2004, even with numbers since 2002 boosted by classification changes. Scotland (4), London (3) and the North West (3) lost most departments, and East Anglia losing two was left without any. Student numbers reflected in part the closures, but other factors came into play including reputation and success in the RAE.

4.18 Combining the trends from the different data sets we can estimate that applications from home students fell by 637 from 1994 to 2004 (22.9 per cent). But 96.0 per cent were accepted in 2004 against 88.6 per cent in 1994. Acceptances were, however, on higher A-level grades, with 39.9 per cent more admitted on the equivalent of an A and two Bs or higher and 36.3 per cent fewer successful on the equivalent of a B and two Cs or lower. There has been an upward trend in recruitment from the European Union and overseas, but even in the 2004 figures, the most recent available, these students comprised only 8.8 per cent of the intake.

5. School Background and Gender

5.1 Independent schools are understood by some to be the refuge of physics as an identifiable subject in schools. This belief can be traced back to an analysis by Smithers (1997) of the changing patterns of subject combinations by school type and gender, and redrawn as Chart 5.1. It was found that the sciences contributed a decreasing proportion of A-level combinations for male students in both maintained and independent schools, but the drop was sharper in the maintained sector so that by 1994, the last year for which this run of statistics was published, proportionally more were studying the subject in independent schools.

Chart 5.1: A-Level Science Combinations by School Type



Source: Smithers, 1997.

5.2 For female students the difference was even more marked. From roughly the same starting point a wide gap opened. By 1994, in percentage terms, females taking science A-levels in independent schools were not far short of the male students in maintained schools. These results were highlighted by Kealey (2005) in a polemic in *The Spectator* in which he blamed national curriculum science for undermining the foundations of science studies.

5.3 Unfortunately, the data series on which Chart 5.1 is based was not continued much beyond the splitting of the sixth form colleges from maintained schools in 1993, so it can shed no light on what has happened in the last decade. But we do know from Chart 2.2 (page 4) that the situation in physics mirrored the trends in science combinations through to 1994, with steeper falls in maintained schools and the sixth and FE colleges than in the independent sector. But in the last decade the decline has been more evenly spread between the independent (-11.7 per cent) and maintained sectors (-14.5 per cent), with the major hit being taken by further education (-41.7 per cent).

Data Sets

5.4 In order to take the story of school background on entries to university physics courses further, we commissioned special analyses from the UCAS. Unfortunately these are subject to certain constraints. Data were not available for 1994 and 1995, and the classification of subjects including physics was revised in 2002 as in the HESA data set considered in the previous chapter. A further limitation is that the grouping of school and college types was changed in 1998. This led to the confounding of grammar schools with grant maintained schools so that they cannot always be meaningfully separated out from other maintained schools.

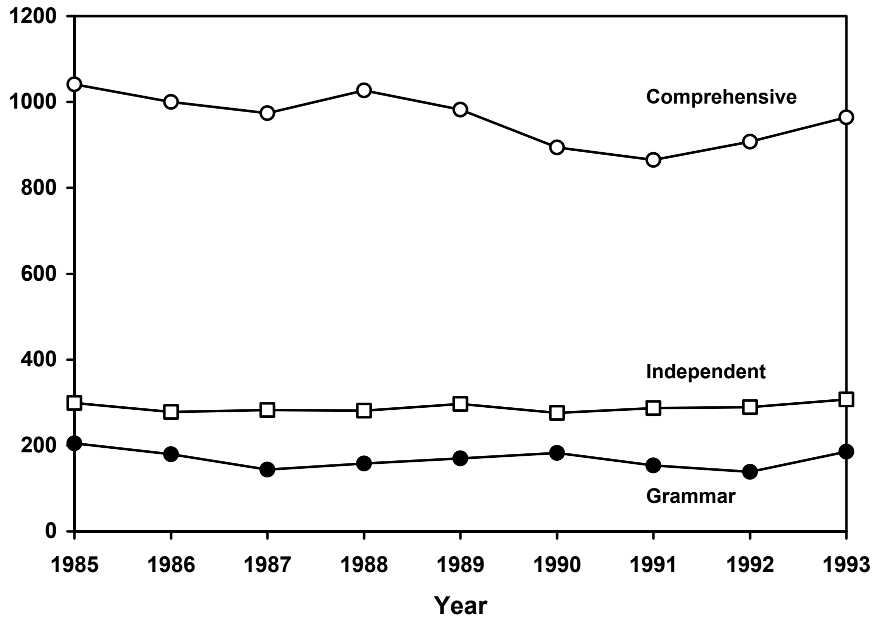
5.5 We also had data available to us for the years 1985 to 1993 from the Universities Statistical Record for the pre-1992 universities, in which it is possible to distinguish the grammar schools. Our USR data set only applies to England and Wales whereas the UCAS data cover the UK. As desirable and interesting as it would have been to draw trend lines for the various school types from 1985 through to the present it was simply not possible given the data available. Our examination of the time course, therefore, comes in three steps: changes from 1985 to 1993 from the USR data; changes from 1998 to 2001 based on UCAS using the old subject classification; and changes from 2002 to 2005 from the UCAS analyses using the revised subject classification.

School and College Background

5.6 In spite of the discontinuities a reasonably consistent picture emerges. Chart 5.2 shows that in the various data runs the proportions of first-year students coming from the different school and college types remain at similar levels. Between 1985 to 1993 university physics intake in England and Wales from comprehensive schools (which still included the sixth form colleges) hovered around 58 per cent and that from grammar schools around 10 per cent. Consistent with Chart 2.3 (page 5), which showed the changing proportions of A-level entries by school type, there was a small increase in the share from independent schools, with over the nine years the contribution from the sector averaging out at 17.3 per cent of the total. In the classification available, further education was included in the 'other' category and again consistent with Chart 2.3 its contribution fell. Chart 5.3 records a drop of 18.4 per cent in this category between 1985 and 1993.

5.7 The lower graph in Chart 5.2 also shows consistency in spite of the redefinitions. If we combine the sixth form colleges with the maintained schools we find that between 1996 and 2005 their joint contribution to physics intake in the larger university system averaged out at 70.8 per cent compared with the 67.6 per cent between 1985 and 1993 for the old universities in England and Wales shown in the upper graph.

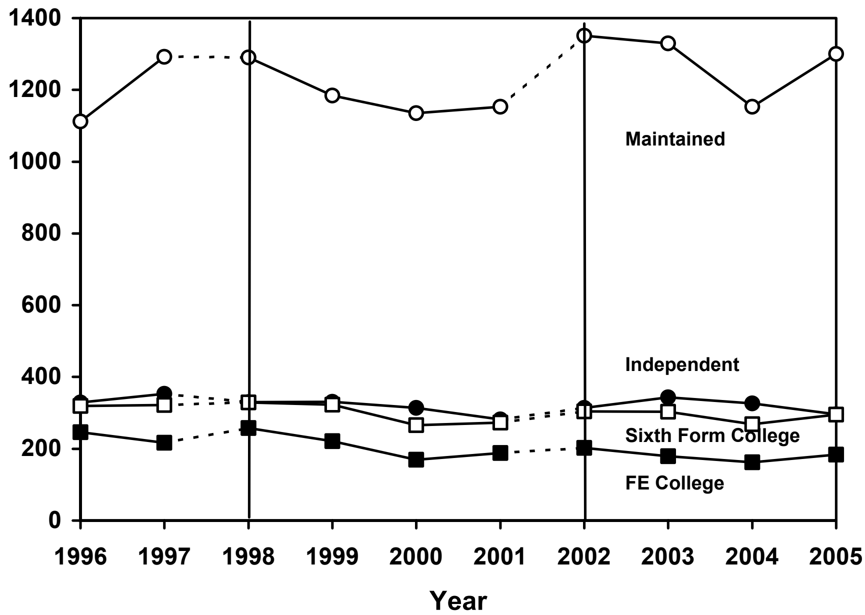
Chart 5.2: University Physics Students[1] by School Type[2]



1. First-year, full-time, UK-domiciled with A-level physics.

2. Sixth Form Colleges still categorised as comprehensive schools. Further Education Colleges classified under other which along with unknown is not shown in this chart but is included in Chart 5.3

Source: Universities Statistical Record. Data applies to universities only, not the polytechnics. This particular set covered universities in England and Wales.



1. First-year, full-time, UK-domiciled with A-level physics.

2. Grammar schools included with other maintained schools since confounded with grant maintained schools in coding.

Source: Special analyses from UCAS. Coding of school types changed in 1998 and subject classification was revised in 2002. Vertical lines mark the discontinuities.

5.8 The independent schools' 'share' appears to fall from 17.3 per cent in 1985-93 to 14.9 per cent in 1996-2005. But the earlier period refers only to the pre-1992 universities to which their students tend to gravitate. The joint contribution of FE colleges and 'other/unknown' was 14.3 per cent compared with the earlier 15.1 per cent. In the period 1996-2005, FE students comprised two-thirds of the 'other/unknown' group, so it is reasonable to assume that the changes in this category from 1985 to 1993 will have reflected developments in the sector.

5.9 Chart 5.2 shows the relative contributions of the school and college types, but it does not bring out the trends in raw numbers. These are set out Chart 5.3. It is apparent that the overall trend in recruitment is downward, so the consistency of Chart 5.2 reflects falls across the board.

Chart 5.3: Changing Intake to Physics Degrees by School Type

School Type	Change[1] 1985-1993		Change[2] 1998-2001		Change[3] 2002-2005	
	N	%	N	%	N	%
Maintained	-96	-7.7	-137	-10.6	-51	-3.8
Independent	+8	+2.7	-48	-15.2	-18	-5.7
Sixth Form College	n/a	-	-56	-17.0	-9	-3.0
FE College	n/a	-	-70	-27.1	-18	-8.9
Other/Unknown	-53	-18.4	+19	+19.4	+17	+15.2
Total	-141	-7.7	-292	-12.7	-79	-3.5

1.USR data for universities in England and Wales. Full-time, first-year, UK-domiciled students with A-level physics.

2. UCAS data for UK universities. Full-time, first-year, UK-domiciled students with A-level physics.

3. Differs from 2 in classification of physics changed adding in students on combined degrees including education.

Source: CEER's USR dataset and specially commissioned analyses from UCAS.

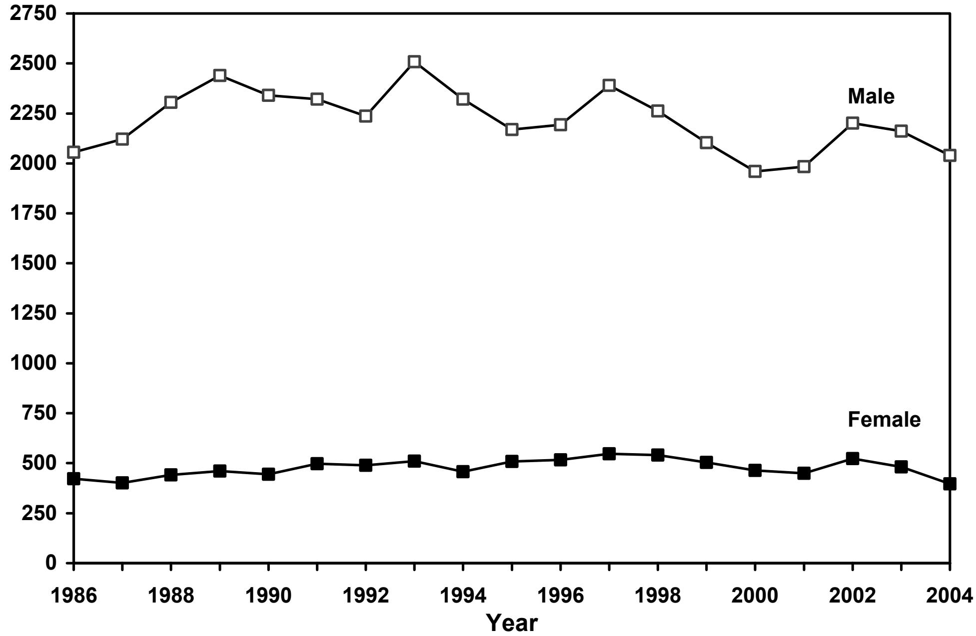
5.10 The sharpest reduction was in the intake from the further education colleges, but apart from the independent sector between 1985-93 and 'other/unknown' between 1998-2005, there were falls in all categories. Although there were signs that the contribution from the independent schools was increasing in the earlier period this has not been sustained and the major shift in recruitment patterns that could have been forecast from Charts 2.2 and 5.1 has not, in fact, occurred.

Gender

5.11 Chart 5.1 also hints that the gender balance in science could be altering as take-up is sustained among girls in independent schools in the face of the decline elsewhere. However the time course of physics entries in Chart 2.6 (page 7) indicates that, even if this is occurring in science generally, it probably does not extend to physics. As we saw in that chart, whereas the percentage of female entries to A-level physics almost doubled from 12.2 per cent in 1951 to 23.2 per cent in 1986 since then, over the past two decades, the proportion has varied only slightly from the average of 22.4 per cent.

5.12 In Chart 5.4 we present a similar run of data for university physics courses. It shows that, over the same period, the female intake has ranged from 547 to 396 (the most recent figure), with a mean of 477. As a proportion, it averages out at 18.5 per cent.

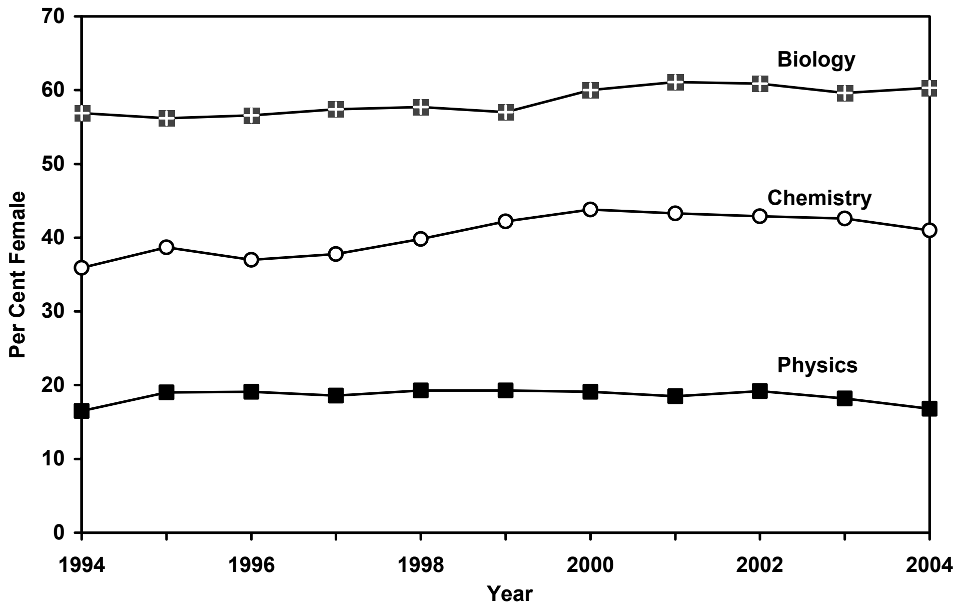
Chart 5.4: Acceptances to Physics Degree Courses[1] by Gender



1. Home-domiciled acceptances to UK universities, all entry qualifications.
Sources: UCCA and PCAS to 1993, UCAS 1994 to present.

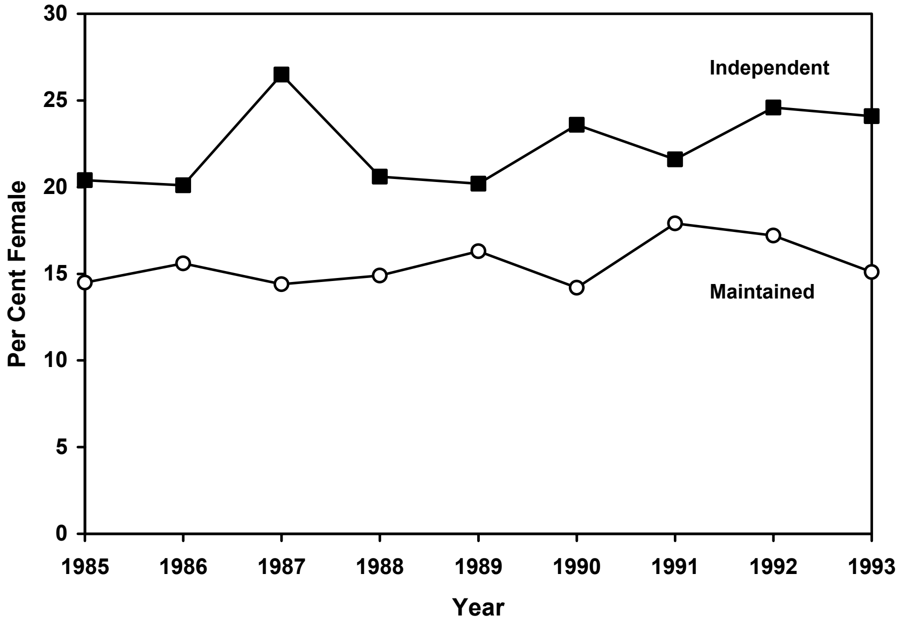
5.13 It appears that while girls comprise less than a quarter of the A-level physics entries, even fewer go on to study for physics degrees. This is not because they do less well at A-level. In fact, typically, they get the better results. In 2005, for example, 34.2 per cent of the female A-level physics students were awarded A-grades against 27 per cent of the males, and 74.8 per cent achieved A-C compared with 66.2 per cent.

Chart 5.5: Per Cent Female Students on Science Degree Courses



Source: UCAS published statistics on acceptances.

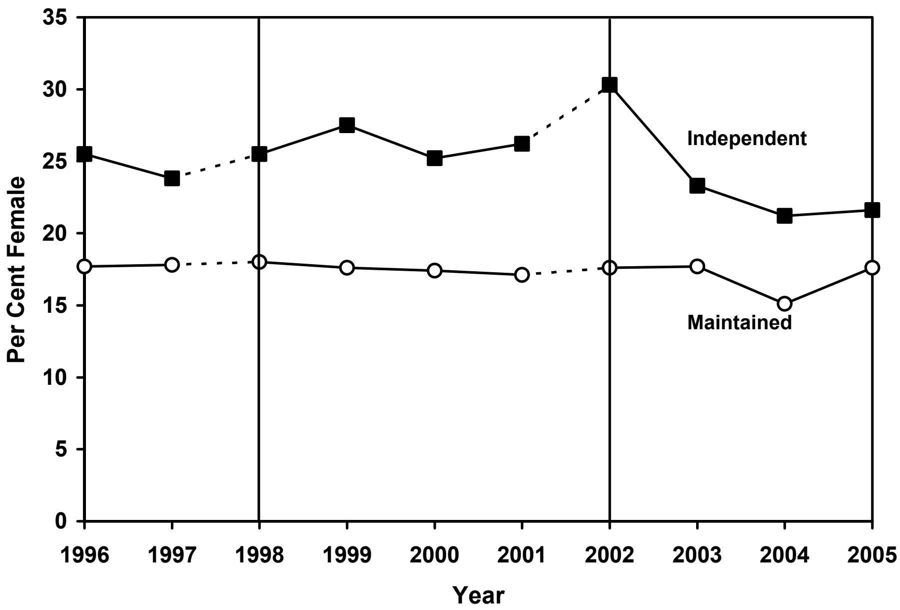
Chart 5.6: Female HE Physics Students[1] by Sector[2]



1. First-year, full-time, UK-domiciled with A-level physics.

2. Maintained sector includes all secondary schools including grammar, and sixth form colleges, but not further education colleges.

Source: Universities Statistical Record. Data applies to universities only, not the polytechnics. This particular set covered universities in England and Wales.



1. First-year, full-time, UK-domiciled with A-level physics.

2. Maintained sector includes all secondary schools including grammar, and sixth form colleges, but not further education colleges.

Source: Special analyses from UCAS. Coding of school types changed in 1998 and subject classification was revised in 2002. Vertical lines mark the discontinuities.

5.14 The gender ratio in the main science subjects at university differs considerably. Chart 5.5 shows that in biology the average proportion of female admissions for the past decade was 58.5 per cent; in chemistry it was 40.5 per cent; in physics it was just 18.5 per cent. And whereas there have been increases in biology and chemistry, in physics there has been little change.

5.15 The science results of Chart 5.1 are, however, borne out for physics in one respect. Chart 5.6 shows that there is consistently a higher percentage of females embarking on physics degrees from independent than maintained schools. Over the 19 years for which we have information from 1985 to 2005 the average for independent schools was 23.8 per cent compared with 16.5 per cent. This is sometimes claimed to be a beneficial consequence of the higher proportion of single-sex schools among independent schools (Smithers and Robinson, 2006). But more likely it reflects the higher ability levels resulting from academic selection (Smithers and Collings, 1981). Wrapped up in the overall figures for the maintained sector are those for the grammar schools. Like the independent schools, they are more often single-sex and they are selective. Chart 5.7 shows the proportion of female students going from them on to physics degrees is similar as well. But even from these school types the gender ratio of female to male is less than one in three (less than 25 per cent).

Chart 5.7: Grammar and Independent

Sample Years	Per Cent Female Entrants to Physics Degrees	
	Grammar	Independent
1985	16.6	20.4
1993	20.4	24.1
1996	26.0	25.5
2005	23.1	21.6
Average 1985-2005	24.0	23.8

Sources: USR 1985-1993; UCAS 1996-2005; see Charts 5.2 and 5.9 for full description

Resumé

5.16 Contrary to common belief, no shift to independent schools was detected in the intakes to university physics departments. Over two decades, in spite of drawing on different data sets applying to different populations, there was consistency in relation to school background. The maintained schools and sixth form colleges contributed an average of 70.8 per cent of the intake between 1996 and 2005 compared with 67.6 per cent to the old universities between 1983 and 1995. The corresponding figures for independent schools were 14.9 per cent and 17.3 per cent respectively, but this is consistent with their students mainly opting for the old universities. Overall, there were falls in the physics intake from all school backgrounds, with the sharpest reduction being from the further education colleges.

5.17 Proportionally fewer girls read physics at university than take it at A-level. In the past decade it averages out at 18.5 per cent compared with the 22.4 per cent at A-level, in spite of their better A-level results. So girls are not only less likely to study A-level physics, but those that do are less likely to study physics at university. The percentage of female students is less than a third of that in biology (58.5 per cent) and less than half that in chemistry (40.5 per cent). As a proportion by gender, relatively more girls from independent than maintained schools read physics – 23.8 per cent against 16.5 per cent – with the grammar schools similar to the independent schools.

6. Subject Choices

6.1 The indications in Chapter 5 that sixth formers in independent schools are more likely to take A-level physics and go to university are borne out by direct calculation. Chart 6.1 shows the proportions of first-year full-time students with A-level physics by school background in 2004 (the latest on which the calculation could be made). It shows that while about one in seven of the A-level students in independent schools and about one in ten in grammar schools took physics, for comprehensive schools and sixth form colleges this reduced to one in 16 and one in 25 respectively.

Chart 6.1: A-Level Physics by School Background[1]

School Type[2]	Second Year Sixth Form Population[3]	HE Entrants With A-Level Physics	Per Cent
Comprehensive	163,924	10,299	6.2
Grammar	28,927	2,973	10.2
Independent	34,889	5,040	14.4
Sixth Form College	73,422	2,987	4.0

1. 2004 the latest year for which these calculations could be made.

2. Take-up in FE Colleges could not be calculated on the available data, but there were 2,043 entrants from the sector in 2004, which we estimate to be about one per cent of the 17-year-olds for whom the sector caters through its many forms of provision.

3. Aged 17 at the beginning of the school year in England, Wales and Northern Ireland.

Sources: UCAS for university entrants with A-level physics; pupil numbers from CEER database, Welsh Assembly website and Northern Ireland Department of Education website.

6.2 Chart 6.1 looks at the school backgrounds of students passing A-level physics and going to university. In Chart 6.2 we ask how many are actually reading physics.

Chart 6.2: Students by School Type and Gender on Physics Degrees

School Type	Gender	HE Entrants with A-level Physics[1]	Taking Physics Degrees[1]	Per Cent 1996-2005
Maintained	Male	10,836	1,010	9.3
	Female	3,160	220	7.0
Independent	Male	3,910	241	6.2
	Female	1,446	80	5.5
Sixth Form College	Male	2,677	254	9.5
	Female	656	46	7.0
FE College	Male	1,853	171	9.2
	Female	511	31	6.1
Other/Unknown	Male	1,820	90	4.9
	Female	608	17	2.8
Gender Totals	Male	21,096	1,766	8.4
	Female	6,381	395	6.2
Overall Total	Both	27,477	2,160	7.9

1. Means calculated for the period 1996-2005.

Source: Specially commissioned analysis from UCAS.

6.3 It emerges that in the past decade, overall only about eight per cent take physics itself, the rest going on to other subjects. Although proportionally more sixth formers in independent schools enter university with A-level physics, they were less likely to take physics *per se*. Whereas 9.3 per cent of the male entrants from maintained schools read physics (with similar proportions from sixth-from and FE colleges), this was true of only 6.2 per cent of the male students from independent schools. However, even taking this into account, proportionally half as many again (52 per cent more) of sixth formers from independent schools read physics at university as from maintained schools (even with the grammars included). The 'other/unknown' group had fewest studying physics. This is likely to be dominated by those entering university later in life, which would help explain their distinctive subject profile (see Chart 6.4, page 34).

6.4 Chart 6.2 also reinforces what we found in Chapter 5 that female students with A-level physics were less likely to study physics *per se* at university than their male counterparts, and that holds for all school/college types. So not only are girls much less likely to study A-level physics, but those who do less often take physics at university. Chart 6.3 takes the story further by providing the details of the subject choices by gender, again for the ten years 1996-2005.

Chart 6.3: Subject Area by Gender

Subject Area	Female	Male	All[1]
Physics	6.2	8.4	7.9
Physics Related[2]/Combinations	2.4	2.1	2.1
Other Physical Sciences	9.5	7.0	7.6
Total Physical Sciences	18.1	17.4	17.6
Medicine and Dentistry	23.9	8.2	11.8
Biological Sciences	9.3	3.9	5.2
Veterinary Science & Agriculture	3.4	0.6	1.2
Maths & Computing Sciences	8.9	18.1	16.0
Engineering & Technology	12.1	29.2	25.2
Architecture, Building & Planning	2.3	2.4	2.4
Social Studies	3.8	4.2	4.1
Business & Administration	2.7	3.4	3.3
Creative Arts & Design	2.2	2.0	2.0
Other[2]	4.0	2.3	2.7
Combinations	9.2	8.2	8.4
Mean N 1996-2005	6,381	21,096	27,477

1. Means for 1996 -2005

2. Materials science and astronomy.

2. Includes mass communication and documentation; languages and related disciplines; historical and philosophical studies; and education.

Source: Specially commissioned analysis from UCAS.

6.5 Female students are more likely to take 'other physical sciences', for example, chemistry and forensic science, but the striking differences are in medicine and dentistry, veterinary science, engineering and technology, and maths and computing.

In percentage terms, female students with physics A-level were almost three times as likely to study medicine and six times, veterinary science. In contrast, their male counterparts were more than twice as likely to read engineering and technology and maths and computing. There was also a substantial difference in the proportions in the biological sciences. Thus even students with the talent and interest to pass physics at A-level tend to opt for subjects at university that are typically associated with their gender.

6.6 In Chart 6.4 we cross-tabulate the university subjects studied by students holding A-level physics with their school backgrounds for the ten years 1996-2005. Over the decade the universities had an average annual intake of 27,476 such students. The highest proportion went to engineering and technology (25.2 per cent) followed by the physical sciences (17.6 per cent), maths and computing sciences (16.0 per cent), medicine and dentistry (11.8 per cent), together accounting for over 70 per cent of the intake. Combined studies (8.4 per cent), biological sciences (5.2 per cent) and social studies (4.1 per cent) contributed a further 17.7 per cent. The remaining 11.6 per cent were scattered across a wide variety of other fields.

Chart 6.4: Subject Areas of Students with Physics A-Level by School Type[1]

Subject Area	**Per Cent by School/College Type**						**Total**
	Maint[2]	**Gram**	**Ind**	**SFC**	**FE**	**Other/ Unknown**	
Physics	9.3	6.7	6.0	9.0	8.6	4.4	7.9
Physics Related[3]/ Combinations	2.6	2.0	1.5	2.3	2.4	1.3	2.1
Other Physical Sciences	8.6	6.2	6.8	8.4	7.4	5.7	7.6
Total Physical Sciences	20.5	14.9	14.3	19.7	18.4	11.4	17.6
Medicine and Dentistry	8.7	14.4	14.9	9.2	10.7	21.1	11.8
Biological Sciences	5.2	5.0	5.6	4.6	5.1	5.0	5.2
Veterinary Science & Agriculture	0.9	1.3	1.8	0.8	1.0	1.9	1.2
Maths & Computing Sciences	17.7	14.6	11.6	19.2	16.8	14.1	16.0
Engineering & Technology	26.1	26.6	26.1	27.9	22.8	15.9	25.2
Architecture, Building & Planning	2.3	2.8	2.4	2.4	2.4	2.5	2.4
Social Studies	3.8	4.2	5.9	2.9	2.7	4.9	4.1
Business & Administration	3.1	4.2	3.3	2.6	2.5	4.6	3.3
Creative Arts & Design	1.4	1.1	1.0	1.3	8.0	3.8	2.0
Other[4]	2.3	2.5	2.8	1.9	2.4	5.9	2.7
Combinations	8.1	8.2	10.2	7.5	7.4	8.9	8.4
Mean N 1996-2005	11,163	2,833	5,356	3,333	2,363	2,429	27,477

1. For the years 1996 –2005.

2. Includes comprehensive, other secondary and city technology colleges.

3. Materials science and astronomy.

4. Includes mass communication and documentation; languages and related disciplines; historical and philosophical studies; and education.

Source: UCAS (specially commissioned analyses).

6.7 The distribution within the various school/types follows this broad pattern, but with some interesting differences. We have already noted that those from independent schools were less likely to read physics. This is also true of the students from grammar schools and, for both groups, it applies to the physical sciences generally. Instead, Chart 6.4 shows they were more likely to be taking medicine and dentistry. More than twice as many students with A-level physics from independent schools read medicine and dentistry as take physics, and the ratio is similar for grammar schools. In contrast, more from comprehensive schools took the science itself. Students with physics A-levels from comprehensive schools and sixth form colleges were also more likely to be found in maths and computing. A relatively high proportion of the students from independent schools were taking subjects in the social sciences category, which includes law.

6.8 Students from further education colleges were distinctive in their tendency to take creative arts and design where they were a third of the students (33.6 per cent), probably reflecting the well-established arts foundation courses in this sector. The students classified as ‘other/unknown’ (of whom 98.6 per cent ‘unknown’) also form a distinctive group. Over a fifth (21.1 per cent) were reading medicine, and only 41.4 per cent compared to the overall figure of 58.8 per cent were in the core areas of the physical sciences, engineering and technology, and maths and computing. The students with school background unrecorded were also more likely than the students generally to be taking social studies (including law) and subjects like education, history and philosophy, mass communication, and documentation and languages that we have grouped as ‘other’. It is probable that the school/college background of at least some has not been recorded because they have entered university later in life, and it appears that they have been drawn more by the chance of a prestigious professional qualification or the opportunity to pursue particular interests, than wanting to make a career in engineering and the sciences. This is consistent with the evidence that people are attracted to, and achieve in, different fields at different ages (Lehman, 1953).

6.9 The differences between the school types are not due to differences in the gender balance within them. Chart 6.5 shows the subject choices of male and female students with A-level physics in comprehensive and independent schools in the decade 1996-2005. Both the gender differences (see Chart 6.3) and the school type differences (see Chart 6.4) already reported show up when the gender split is made within school-types. Female students in both comprehensive and independent schools were much more likely to be studying medicine and dentistry and veterinary science and much less likely to be reading engineering and technology, and maths and computing, than their male counterparts, though with the school type differences overlaid. In physics there were similar differences with school type and gender, but in the physical sciences as a whole the school effect was more apparent than the gender association. Girls achieving A-level physics in comprehensive schools were more likely than the other groups to be taking ‘other physical sciences’ at university, a category which includes fields like forensic science as well as the traditional subjects. They were also the most likely to be found in the biological sciences.

Chart 6.5: Subject Areas by Gender and School Type

Subject Area	Comprehensive[1] %Female	Comprehensive[1] %Male	Independent %Female	Independent %Male
Physics	7.4	9.8	5.6	6.2
Physics Related/Combinations	2.9	2.5	1.8	1.4
Other Physical Sciences	11.4	7.8	7.8	6.5
Total Physical Sciences	21.7	25.2	15.2	14.1
Medicine and Dentistry	20.4	5.7	25.1	11.1
Biological Sciences	10.4	3.9	8.4	4.6
Veterinary Science & Agriculture	2.9	0.4	4.3	0.9
Maths & Computing Sciences	10.4	19.6	7.3	13.2
Engineering & Technology	12.1	29.8	13.6	30.8
Architecture, Building & Planning	2.1	2.3	2.5	2.3
Social Studies	3.4	3.9	4.9	6.2
Business & Administration	2.7	3.2	2.4	3.6
Creative Arts & Design	1.3	1.4	1.1	1.0
Other[2]	3.7	2.0	3.7	2.5
Combinations	8.9	7.8	11.4	9.8
Mean N 1996-2005	2,315	8,848	1,446	3,910

1. For the years 1996 –2005.

2. Includes comprehensive, other secondary and city technology colleges.

3. Materials science and astronomy.

4. Includes mass communication and documentation; languages and related disciplines; historical and philosophical studies; and education.

Source: UCAS (specially commissioned analyses).

6.10 In the charts so far in this chapter we have aggregated the data for the years 1996-2005 to smooth out variations, but this could mean that we are missing important trends. In Chart 6.6 we show the time course and a first reaction has to be that the years look very much alike. Apart from the step change caused by subject re-classification from 2002, there are few differences that immediately catch the eye.

6.11 There are, however, indications of trends in the period 1998-2001 which are obscured, to some extent, by the later re-classification. A broad generalisation would be that students with an A-level in physics seem to be moving away from physics itself, the other sciences, and medicine and dentistry towards the creative arts and design, social studies, architecture, building and planning, and a wider range of subjects. But Chart 6.6 does not take account of the changes in the total intakes with A-level physics so that similar percentages could reflect either an increase or decrease in actual numbers according to whether the overall intake with A-level physics has been falling or rising.

6.12 In Chart 6.7 we home in on the actual numbers of students, comparing the two ends of each of the three data sets available to us. This approach does show up the changing pattern of subject choice by students with A-level physics, especially when we sum across the three sets to record the net change (bearing in mind the missing years).

Chart 6.6: Time Course of Subject Areas of Students[1] With A-Level Physics

Subject Areas	Per Cent by Year[2] 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Physics	8.0	8.3	8.3	7.6	7.1	7.2	8.0	8.2	7.8	8.3
Physics Related[3]/ Combinations	2.2	2.3	2.1	2.0	2.0	2.2	2.4	2.1	2.2	1.9
Other Physical Sciences	8.4	8.2	8.1	7.5	7.0	6.6	7.3	7.7	7.6	7.9
Total Physical Sciences	18.6	18.8	18.5	17.1	16.1	16.0	17.7	18.0	17.6	18.1
Medicine and Dentistry	12.6	12.0	11.8	11.5	11.8	11.5	11.4	11.5	12.1	12.1
Biological Sciences	5.2	5.6	5.1	5.1	4.6	4.6	5.6	5.4	5.2	5.4
Veterinary Science & Agriculture	1.2	1.1	1.0	1.1	1.1	1.1	1.3	1.5	1.5	1.4
Maths & Computing Sciences	15.3	15.6	16.5	17.7	18.1	18.6	16.2	14.7	13.3	13.1
Engineering & Technology	27.9	26.4	26.3	26.0	25.4	23.7	22.7	23.2	25.4	25.5
Architecture, Building & Planning	1.9	2.0	2.0	2.0	2.2	2.2	2.4	2.9	3.1	3.3
Social Studies	3.2	3.4	3.6	3.9	3.9	4.4	5.0	5.0	4.8	4.2
Business & Administration	2.9	3.0	3.0	3.2	3.3	3.5	3.6	3.4	3.5	3.3
Creative Arts & Design	1.0	1.7	1.8	1.9	2.1	2.3	2.2	2.4	2.6	2.5
Other[4]	2.8	2.4	2.2	2.2	2.6	2.9	2.9	3.1	2.9	3.1
Combinations	7.6	8.0	8.3	8.3	8.9	9.3	9.1	8.8	8.1	8.0
N	26,614	27,947	27,964	28,348	27,847	28,096	28,501	27,321	25,716	26,408

1. First-year, full-time, UK-domiciled with A-level physics.

2. Subject classification was revised in 2002.

3. Materials science and astronomy.

4. Includes mass communication and documentation; languages and related disciplines; historical and philosophical studies; and education.

Source: UCAS (specially commissioned analyses).

6.13 In Chart 6.7 we can see that over the two decades the biggest loss has been from the physical sciences followed by the biological sciences and medicine and dentistry. The gainers have been engineering and technology, architecture, building and planning, and the creative arts and design, plus a variety of other subjects and combinations. Taking into account all the net gains and losses across the 17 years, it appears that there were 1,681 fewer first-year students with physics A-level (or about 99 per year), with a drop of 512 in physics itself (or about 30 per year).

6.14 For some subject areas, including the main gainers and losers, the direction of change has been the same across the three periods. But other subjects have been more variable. There were major increases in maths and computing, social studies and business and administration between 1998-2001 which were outweighed by the losses between 2002 and 2005. A decrease in engineering and technology between 1996 and 2001 was compensated to some extent by a gain 2002-05. The creative arts and design which did not exist as a category in the old universities showed a major increase in the A-level physics students it attracted between 1998 and 2001 and this was sustained in 2002-05. Engineering and technology lost physics students 1998-2001, but gained them in the periods either side. Over the twenty years, students with A-level physics have tended to spread more widely across the subjects with a growth in the 'other' category and in combined studies, though in the case of the latter apparently some fall-off 2002-2005 due to re-classification.

Chart 6.7: Trends in University Subjects of Students With A-Level Physics

Subject Area	Change[1] 1985-1993		Change[2] 1998-2001		Change[3] 2002-2005		Net Change
	N	%	N	%	N	%	
Physics	-141	-7.7	-292	-12.7	-79	-3.5	-512
Physics Related/ Combinations	+53	+10.6	+4	+0.7	-170	-25.2	-113
Other Physical Sciences	-152	-7.5	-412	-18.2	+11	+0.5	-553
Total Physical Sciences	-240	-5.5	-700	-13.5	-238	-4.7	-1,178
Medicine and Dentistry	-463	-15.6	-75	-2.2	-36	-1.1	-574
Biological Sciences	-376	-24.5	-117	-8.2	-165	-10.3	-658
Veterinary Science & Agriculture	-129	-37.6	+35	+12.6	+22	+6.1	-72
Maths & Computing Sciences	0	0.0	+633	+13.7	-1,150	-24.9	-517
Engineering & Technology	+950	+21.8	-698	-9.5	+262	+4.1	+514
Architecture, Building & Planning	+62	+40.0	+47	+8.4	+171	+24.6	+280
Social Studies	-66	-7.7	+231	+23.0	-319	-22.4	-154
Business & Administration	-204	-41.0	+126	+14.9	-153	-15.1	-231
Creative Arts & Design	0	0.0	+154	+30.4	+21	+3.3	+175
Other[4]	+109	+47.4	+202	+32.5	-16	-1.9	+295
Combinations	+637	+32.1	+294	+12.7	-492	-18.9	+439
Overall Total	+280	+1.4	+132	+4.7	-2,093	-7.3	-1,681

1. USR data for universities in England and Wales. Full-time, first-year, UK-domiciled students with A-level physics.

2. UCAS data for UK universities. Full-time, first-year, UK-domiciled students with A-level physics.

3. Differs from 2 in classification of physics changed adding in students on combined degrees including education.

4. Includes mass communication and documentation; languages and related disciplines; historical and philosophical studies; and education.

Source: CEER's USR dataset and specially commissioned analyses from UCAS.

Resumé

6.15 Sixth formers in independent (14.4 per cent) and grammar schools (10.2 per cent) are more likely to take A-level physics than those in comprehensive schools (6.2 per cent) or sixth form colleges (4.0 per cent), but are also more likely to take subjects other than physics at university. Even so since more students from independent schools had taken A-level physics they were still 52 per cent more likely to read it as a degree subject than those from maintained schools.

6.16 Overall, in the past decade, only about 8 per cent of university entrants with A-level physics have read physics itself. The highest proportions went to engineering and technology (25.2 per cent), maths and computing sciences (16.0 per cent), medicine and dentistry (11.8 per cent) and the other physical sciences (9.7 per cent). The different school/college types followed this broad pattern, but students from independent and grammar schools were more likely to take medicine and dentistry whereas those from comprehensives and sixth form colleges were more likely to take the physical sciences, including physics, and maths and computing sciences.

6.17 The differences between the school types were not due to gender. Male and female students from the same school type tended to opt for the same subject areas, although with the overlaying gender differences. Female students with A-level physics were less likely than male students to study physics at university. They were six times more likely than their male counterparts to study veterinary science, three times more likely to study medicine and dentistry, and over twice as likely to take biological sciences, but only half as likely to read engineering and technology or maths and computing.

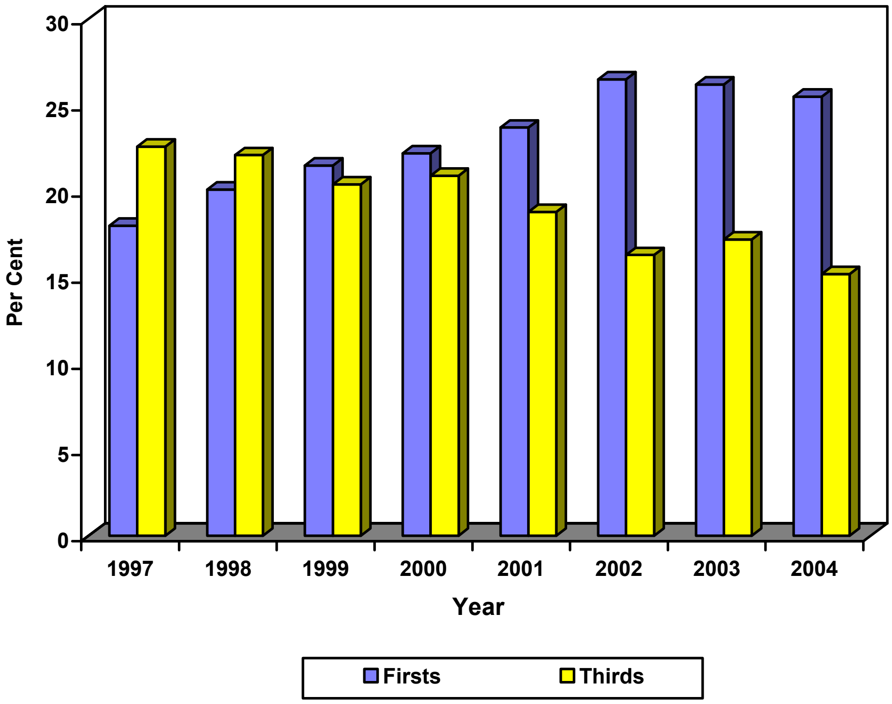
6.18 The distribution of subjects studied by students with A-level physics has been relatively consistent from year to year, but with some shift away from physics itself, the other sciences, and medicine and dentistry towards creative arts and design, architecture, building and planning and a wide variety of other subjects and combinations. Over the past two decades the number of students entering university with A-level physics has dropped by about 100 per year, on average, with 30 lost annually from physics itself.

7. Outputs and Destinations

7.1 In Chapter 2 we noted that A-level physics entries had dropped by 35 per cent from 1990 to 2005 and, in Chapter 4, that those applying were more likely to be offered a place. The question arises: has there been any impact on degree attainment?

7.2 In so far as the awarding process has remained consistent, the results suggest that degree performance has actually improved. Chart 7.1 shows that the proportion of firsts has gone up by 41.6 per cent since 1997, while thirds and passes have fallen by 32.7 per cent. The increase in top awards is consistent with similar trends at A-level and GCSE. Whether this represents real improvement or is mainly due to grade inflation is open for discussion. But it does appear on the surface that at the very least the standard of university physics students has not fallen with the decline in A-level entries.

Chart 7.1: Degree Classes



Source: Students in Higher Education, HESA.

Destinations

7.3 The first destinations statistics published by the HESA operate on the basis of broad categories and are less revealing than those of their predecessor the Central Services Unit in which, for example, it was possible to distinguish those training to be teachers. Nevertheless, the data of Chart 7.2 do show that first-degree graduates in physics were much more likely than those of all other subjects together to move on to further study of various kinds rather than into full-time work.

7.4 About double the proportion of physics graduates went into further study, 32.4 per cent compared to 15.1 per cent, but while more than half graduates in general took up full-time paid work this was the case for only 36.4 of the physics graduates.

Chart 7.2: Destinations of First Degree Graduates, 2004

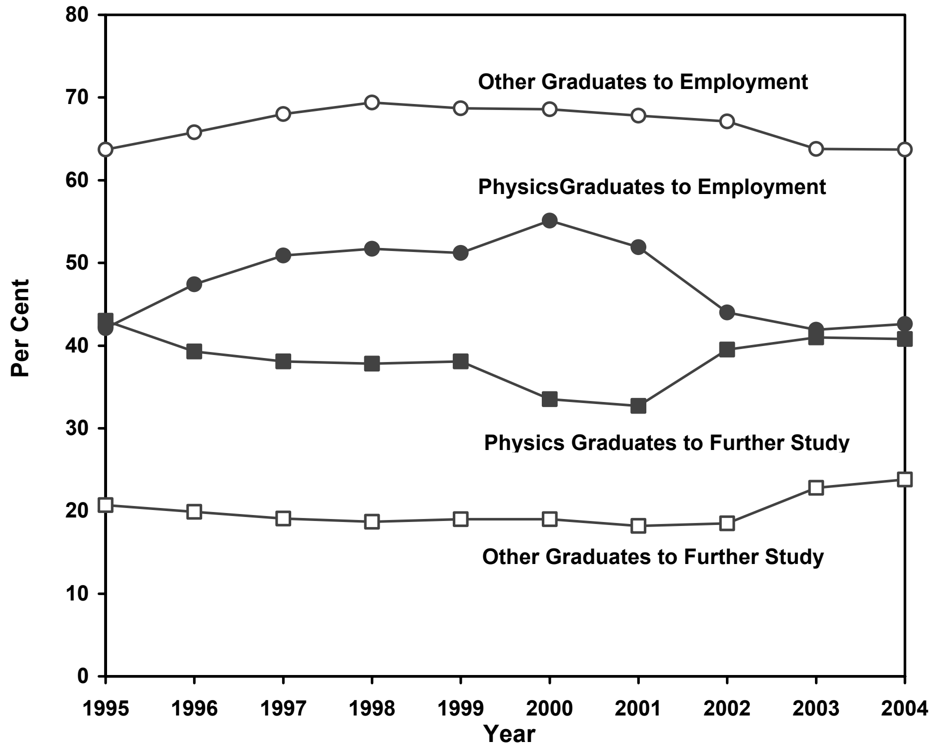
Category	Physics Graduates N[1]	Physics Graduates Per Cent	All Other Graduates N[1]	All Other Graduates Per Cent
Full-Time Paid Work	595	36.4	99,740	55.3
Part-Time Paid Work	95	5.8	13,535	7.5
Voluntary Work	5	0.3	1,580	0.9
Work Plus Further Study	135	8.3	15,665	8.7
Further Study Only	530	32.4	27,155	15.1
Assumed Unemployed	150	9.2	11,695	6.5
Not available for Work	100	6.1	7,170	5.0
Other	200	1.2	1,795	1.0
Total of Known Destination[2]	1,635	100.0	180,230	100.0

1. Rounded to nearest 5.

2. Destination known of 84.3 per cent of the physics graduates and 81.7 per cent of other graduates

Source: First Destinations of Graduates, 2004, HESA.

Chart 7.3: First Destinations of UK Domicile Graduates



Source: First Destinations of Graduates, with classification changes in 2000 and 2002.

7.5 Using somewhat broader definitions, for example, including part-time and voluntary work in 'employment' and further study and training in employment in 'further study', Chart 7.3 shows that the difference between physics graduates and all others as a group has held for the past decade. Graduates in general were consistently more likely than physics graduates to enter employment and less likely to engage in further study. The apparent 'bowing' in the physics data in 2000 and 2001 may have more to do with classification changes than a real difference. It was not associated with changes in the proportions 'unemployed', 'unavailable for employment' or 'other'.

7.6 In HESA's published data teacher trainees are included in, and not distinguishable from, other forms of further study and training. To discover how many of the physics graduates were entering teaching we turn to the comprehensive database of the Teacher Development Agency.

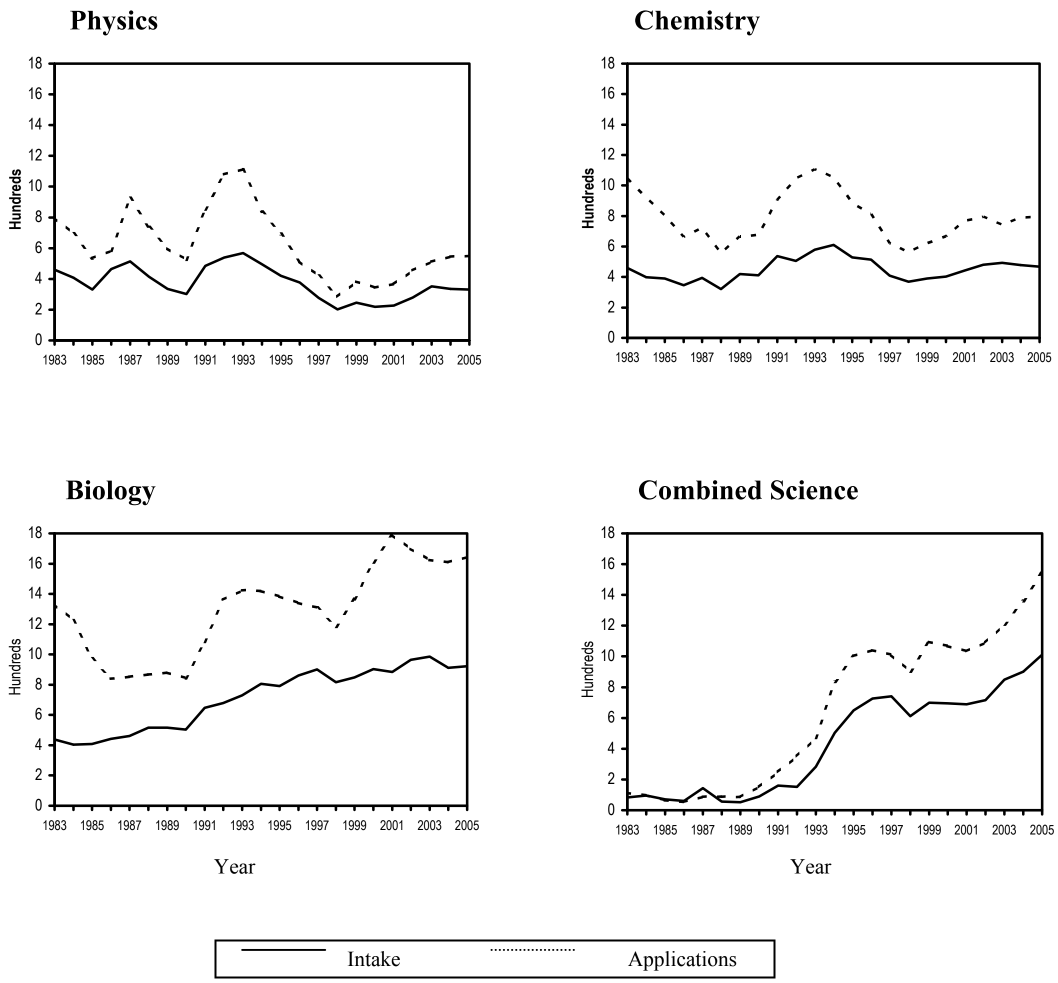
Resumé

7.7 In spite of falling A-level entries and a higher proportion of university applicants being accepted, since 1997 'firsts' in physics have increased by 41.6 per cent and 'thirds or passes' have gone down by 32.7 per cent. Physics graduates are more likely than other graduates to go on to further study and less likely to enter paid employment directly.

8. Physics Graduates into Teaching

8.1 Recruiting sufficient good physics graduates into teaching has been a persistent problem. Chart 8.1 compares applications and acceptances for science PGCEs since data were first collected in this form. It shows that the number of physics applications has fluctuated over the years. It hit a low of 535 in 1985 following which the Conservative government introduced a bursary scheme that gave a temporary boost. It was, however, the economic recession of the early nineties that hoisted applications to their highest level in two decades. But from a high point of 1,114 applications in 1993, there were just 285 in 1998. Since that time new government incentives have brought about some recovery - to 548 in 2005. Nevertheless, finding physics teachers continues to be a struggle. Acceptances vary less than applications, being determined more by the supply of places. It is not clear whether the smoother admissions curve is due to a higher number of unsuitable applicants in the boom years or lowering the entry threshold in the lean.

Chart 8.1: Recruitment to PGCE Science Courses



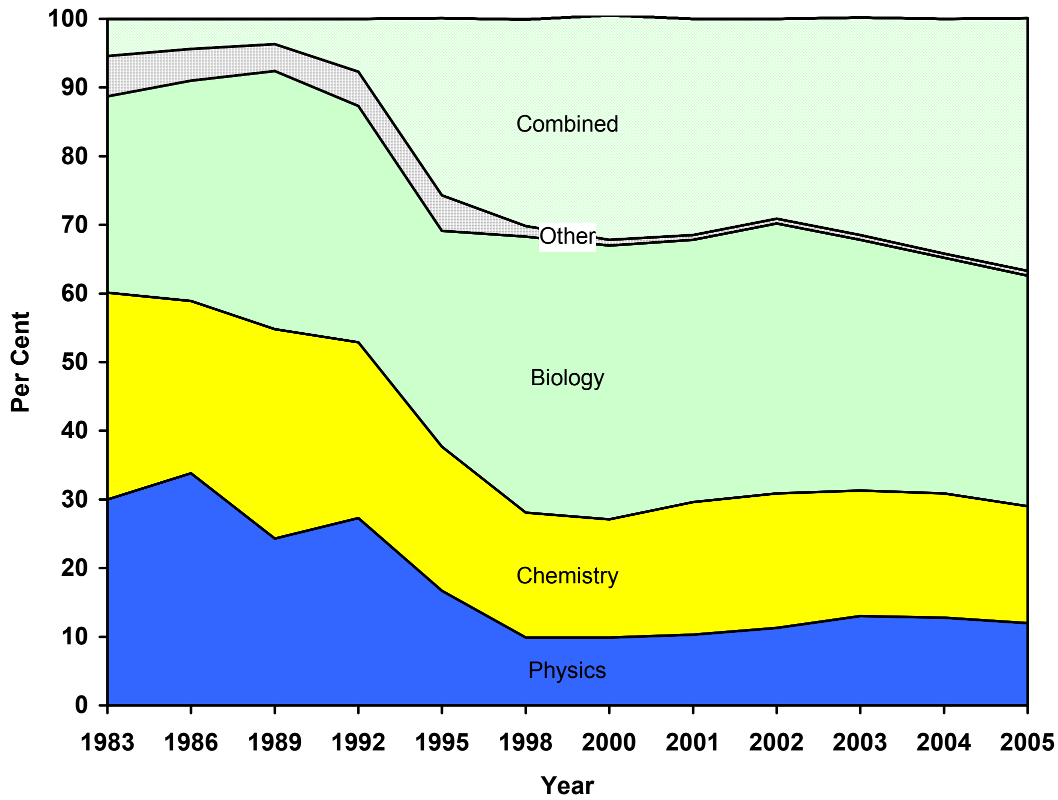
Source: *GTTR Annual Reports.*

8.2 The applications and admissions curves for chemistry are not dissimilar to those for physics. The jump in applications during the economic recession and the impact of recent incentives are both evident. In biology, however, the chart shows that entries have gone up most years. By 2005 they had reached 923 out of 1,644 applicants.

But an even greater change has taken place in combined science. Until 1991 general science was the poor relation of PGCE science courses, but following the designation of 'science' as the national curriculum subject and as a subject at GCSE, from 1992 there has been, as Chart 8.1 shows, considerable growth in general science training places. We will be exploring how they are filled later in the chapter. But, at this stage, it is enough to say that from 250 applicants for 160 places in 1991, combined science has grown so that, in 2005, there were 1,549 applicants of whom 1,012 were recruited.

8.3 These trends have resulted in a considerable shift in the subject specialisms of those training to teach in the sciences. Chart 8.2 presents the picture. While physics comprised 30 per cent of the intake in 1983, in 2005 it stood at only 12 per cent. Chemistry also at about 30 per cent in 1983 is now down to 18.1 per cent. Biology has increased its proportion somewhat – from 28.8 per cent to 34.3 per cent. But the big gainer has been combined science, up from 5.4 per cent to 34.2 per cent.

Chart 8.2: Subject Balance in PGCE Intakes[1] in the Sciences



1. England and Wales.

Source: *GTTR Annual Reports* for 2003 to 2001. From 2002 data taken from GTTR website since from then the Annual reports include Scotland.

8.4 So from a rough parity in 1983 between the three main sciences, biology now dominates with approaching three times as many trainees as in physics and almost double those in chemistry. This would matter less if physicists and chemists were fully represented among the combined science trainees. But, as Chart 8.3 shows, there were almost five times as many biology graduates as physics graduates and three times as many as chemistry graduates in the latest year for which we have figures (TDA Performance Profiles, 2005, for year 2002-03). Only 8.8 per cent of the combined science trainees whose degree subject is known had qualified in physics. Physics graduates are, therefore, not only seriously under-represented in terms of specialist training places, but also on combined science courses. It can be no surprise that our 2005 survey found that 'science' in secondary schools is mainly taught by biologists.

Chart 8.3 Degree Subjects of PGCE Trainees

Degree Subject	On PGCE Course					Total
	Physics	Chemistry	Biology	Comb/ General	Maths	
Physics	154	10	20	56	57	297
Chemistry	6	241	41	83	18	389
Biological Sciences	7	19	568	268	18	880
Medicine and Related[1]	5	11	108	66	7	197
Other Sciences	34	39	135	109	35	352
Engineering & Technology	55	8	10	30	245	348
Other Subjects	11	6	19	24	192	252
Mathematics	5	0	2	1	820	828
Total Known	277	334	903	637	1,392	3,543
Total Unknown	28	32	63	146	165	434
Overall Total	305	366	966	783	1,557	3,977

1. Medicine and Related, Veterinary Science and Agriculture.

Source: Teacher Development Agency, Performance Profiles 2005, data 2002-03.

8.5 Another remarkable figure which the cross-tabulation of degree subjects and teacher training courses reveals is that, as scarce as physics graduates in teacher training are, of the 297 entering in 2002, 57 (19.1 per cent) were training to teach maths. This should be investigated. Part of the explanation may lay in a letter we received from a mature trainee following publication of our physics survey (Smithers and Robinson, 2005) sharing with us why seven of the ten physicists on his science course had dropped out: *"I did not wish to teach biology and chemistry, and I find it ridiculous that there was a comment on my factual knowledge of these, when I have never studied biology and I last studied chemistry many years ago."*

8.6 Certainly, when in our survey we asked heads of physics/science departments across schools and colleges about possible improvements, a number suggested that physics and maths would be a more appropriate training combination. *"The PGCE in science is hopeless! Scrap it, or supplement it with a PGCE in physics and maths. That way teachers get to teach what they are good at!"* Whether this would increase the number of physicists in teaching depends on another possibility: that physicists prefer to teach maths rather than physics because there is not the practical work. If that is the case then a combined physics and maths training course could exacerbate the difficulty in finding physics teachers.

Degree Classes

8.7 Teaching generally finds it hard to attract good graduates. Chart 8.4 shows that, as a whole, science and maths graduates entering teaching obtained less good degrees than their fellows. Physics seems to fare worst of all. In the latest year for which we have figures only 38.9 per cent of the physicists going into teaching had a good degree (first or 2i) compared to the 58.1 per cent awarded, and 23 per cent had a third or unclassified degree against 17.2 per cent.

Chart 8.4 Degree Classes of Teacher Trainees Compared with Fellow Graduates

Degree Class	%Physics		%Chemistry		%Biology		%Maths	
	Teacher Trainees	Graduates	Teacher Trainees	Graduates	Teacher Trainees	Graduates	Teacher Trainees	Graduates
First	12.5	26.2	13.2	23.3	8.6	12.4	15.7	26.1
Upper Second	26.4	31.9	37.2	35.5	48.0	45.4	30.5	33.3
Lower Second	38.0	24.7	35.0	25.6	35.9	31.8	33.1	25.2
Third	16.7	14.5	9.1	11.4	5.5	6.6	14.7	12.5
Unclassified	6.3	2.7	5.5	4.2	2.1	3.8	6.1	2.8
Total Known	287	2,210	363	2,945	860	4,425	798	4,390

Sources: Teacher Development Agency, Performance Profiles 2005, data 2002-03 and HESA Students in Higher Education 2002-2003.

8.8 The degree classes of the physics graduates also differed according to the subject they were training to teach. Chart 8.5 shows that those training to teach physics generally held better degrees than those opting to teach combined science. A similar pattern emerges for chemistry and biology.

Chart 8.5 Degree Classes of Teacher Trainees in the Sciences

Degree Class	Physics Degree		Chemistry Degree		Biology Degree	
	Teach Physics	Teach Combined Science	Teach Chemistry	Teach Combined Science	Teach Biology	Teach Combined Science
First	11.3	9.6	16.3	6.8	9.6	5.8
Upper Second	25.3	21.2	37.0	35.6	50.4	44.0
Lower Second	37.3	42.3	33.5	39.7	30.4	39.0
Third	21.3	17.3	9.3	8.2	4.1	8.1
Unclassified	4.7	9.6	4.0	9.6	1.8	3.1
Total Known	150	52	227	72	561	259

Source: Teacher Development Agency, Performance Profiles 2005, data 2002-03.

8.9 Interestingly, the physicists training to be maths teachers had the best of degrees of all. Chart 8.6 shows that proportionally twice as many had a ‘first’ as those training to teach physics itself, and over three times as many as those training to teach combined science. Over half the physics graduates training to be maths teachers had a ‘first’ or ‘upper second’, the closest approach to the proportions awarded in the subject overall.

Chart 8.6: Teacher Trainees with Physics Degrees

Degree Class	%Teach Physics	%Teach Other Sciences	%Teach Maths	%Total
First	11.3	7.3	23.6	12.5
Upper Second	25.3	28.0	27.3	26.4
Lower Second	37.3	43.9	30.9	38.0
Third	21.3	13.4	9.1	16.7
Unclassified	4.7	7.3	9.1	6.3
Total Known	150	82	55	287

Sources: Teacher Development Agency, Performance Profiles 2005, data 2002-03

Gender

8.10 One of the reasons it may be so difficult to attract physics graduates into teaching is their gender. As we have seen in Chapter 5, and Chart 8.7 reinforces, more than four-fifths of physics graduates are male. But, as Chart 8.7 also shows, proportionally more female graduates than their male counterparts train as teachers. In all cases, except biology, there is a substantial difference and even in biology the percentage of females entering teaching is greater than the proportion of graduates.

Chart 8.7: Gender and Teacher Training

Subject	Teacher Trainees %Male	Teacher Trainees %Female	Degree %Male	Degree %Female
Physics	69.0	31.0	81.5	18.5
Chemistry	47.6	52.4	59.5	40.5
Biology	36.7	63.3	41.5	58.5
Maths	49.6	50.4	61.8	38.2

Sources: Teacher Development Agency, Performance Profiles 2005 and UCAS acceptances first average for the years 1994-2004 (from Chart 5.8).

8.11 The difficulty of achieving a balance in the science backgrounds of secondary school teachers is apparent in the size of the respective pools from which recruitment is made. Taking biology and physics as the extremes: there are 62 per cent more biology than physics graduates, proportionally three times as many are female, and both genders are more inclined to teach (Smithers and Hill, 1989). As we have seen, this leads to more biologists being trained and they also take the lion's share of the places on combined science courses. This must mean that science as taught in secondary schools has a biological flavour which could well influence the science choices of the pupils, and hence the drift away from A-level physics.

Age

8.12 Differences in the interest of recent graduates in training to be science teachers also emerges in the age of the trainees. Chart 8.8 shows that well over half the biologists and mathematicians training to be teachers were aged under 25 and likely to be training for their first jobs, but these were the exceptions. Many of the other groups appeared to be entering teaching as a second career. Nearly three-quarters of those from an engineering or technology background (contributing a fifth of the physics teacher trainees) were aged 25 and over. Well over half of those from non-science backgrounds, those whose degree subjects were not known and from medicine and related subjects were also mature trainees. But this is also the case for the physics and chemistry graduates in teacher training. It looks as though more than half the intakes (even allowing for mature graduates) had tried something else before opting for teaching.

Chart 8.8: Age and Teacher Training by Degree Subject

Degree Subject	Age %Under 25	%25 and Over	N
Physics	44.4	55.6	297
Chemistry	46.3	57.3	389
Biological Sciences	55.7	44.3	879
Medicine and Related[1]	45.2	54.8	197
Other Sciences	48.4	51.6	353
Engineering & Technology	25.3	74.7	252
Other Subjects	38.1	61.9	348
Mathematics	57.0	42.9	828
Not Known	32.5	67.3	434
All Science Trainees	46.7	53.2	3,977

1. Includes agriculture and related subjects; architecture, building and planning; business and administrative studies; mass communication and documentation; languages and related disciplines; humanities; creative arts; education; and combined and general courses.

Source: Teacher Development Agency, Performance Profiles 2005, data for 2002-03.

Teacher Training Outcomes

8.13 The difficulty of recruiting people to train as physics teachers is reflected in the relatively low proportion achieving qualified teacher status. Chart 8.9 shows that, of the 2002 entrants, only just over two-thirds had qualified by 2004. Of the remainder, 18 per cent had dropped out or the qualification had been withheld (for example, for not passing all the tests) and another 15 per cent had not definitely done so and were entered as still to complete. In contrast, in biology with more choice over whom to admit in the first place, 85 per cent had made it to QTS and only 11 per cent had left.

Chart 8.9 Degree Subjects of PGCE Trainees

Teacher Training Outcome	PGCE Course Physics	Chemistry	Biology	Comb/ General	Maths
%Qualified Teacher Status	67.2	81.7	84.7	75.6	75.2
%To Complete	15.1	5.7	4.7	12.6	13.0
%Left or Withheld	17.7	12.6	10.7	11.7	11.8
Total	305	366	966	783	1,557

Source: Teacher Development Agency, Performance Profiles 2005, data for 2002-03.

8.14 Not only were the physics trainees less likely to achieve qualified teacher status, but also more of those completing were choosing not to teach. Chart 8.10 shows eight per cent were not seeking a post, higher than in any of the other subjects, and almost five times the proportion in maths. For the other categories there were few consistent differences across the subjects, though rather more of the biology trainees were teaching in maintained schools and the destinations of the combined science trainees were less likely to be known.

Chart 8.10: Employment of Teacher Trainees in Science and Maths

Employment Status	Per Cent from PGCE Course				
	Physics	Chemistry	Biology	Comb/ General	Maths
Teaching in State School	78.4	78.0	82.8	75.8	80.2
Independent School	4.7	6.0	3.6	5.5	4.5
Still Seeking Post	2.1	3.5	1.5	3.2	1.7
Not Seeking Post	7.9	6.4	5.6	3.0	1.6
Not Known	6.8	6.0	6.5	12.5	8.5
Total	190	282	750	783	1,090

Source: Teacher Development Agency, Performance Profiles 2005, data for 2002-03.

8.15 There were no major differences with subject in the proportions going to teach in independent schools, but in another study it has been shown that it is generally the better qualified, especially when teachers are scarce as in physics, who are tempted into the independent sector (Smithers and Tracey, 2003).

Resumé

8.16 Relatively few physics graduates enter teaching. There are over three times as many training places in biology as there are in physics. In addition, nearly five times as many biology as physics graduates are recruited to teach combined science. From about a third of the science trainees in 1983 physics graduates now comprise only about one in eight. Science in schools is increasingly being taught by biology graduates. Science graduates training to be teachers generally have obtained less good degrees than their fellow graduates. Trainees to teach physics, chemistry and biology tend to hold better degrees than those training to teach combined science. Nearly a fifth of the physics graduates in teacher training train to teach maths. These are among those with the best degrees.

8.17 Females are more likely to enter teaching than males and the small number taking physics degrees contributes to the difficulties in recruiting teachers for that subject. Biology graduates entering teaching are younger than physics graduates. Only just over two-thirds of the physics teacher trainees achieved qualified teacher status in 2003 compared with over 80 per cent in chemistry and biology. Those successfully completing physics teacher training are somewhat less likely to be seeking a teaching post than those training for the other sciences and maths.

7. Discussion

9.1 One of the most distinctive and disturbing trends in English education statistics has been the continuing decline in A-level physics entries. Having reached a peak of 55,728 in 1982, they have fallen most years since to stand at only about half that level in 2005. Two questions arise immediately: why have A-level entries been falling; and how have universities responded to a smaller pool of applicants?

9.2 In so far as the statistical trends help to provide answers, it appears that part of the explanation for the fall in A-level entries is the changes in the curriculum and examinations in education up to age 16. Combined science was made compulsory to that age when the national curriculum was introduced in 1988 because it was thought that too many young people were writing themselves off from some or all of physics, chemistry and biology at too early an early age. The hope was that compulsory science would improve scientific literacy, provide a better platform for A-level studies and redress the imbalances between the sexes in physics and biology especially. In the event, although many more pupils have studied science and taken GCSE exams in it, neither the looked-for increases in physics A-level take-up nor the narrowing of the gender gaps at A-level and university have occurred.

9.3 Physics A-level entries have fallen much less in independent and grammar schools than other parts of the maintained sector, and it is perhaps significant that these two school types have also tended to retain physics as a GCSE subject alongside or instead of the science GCSEs. This cannot be taken as a causal relationship, but as we showed in the 2005 survey (Smithers and Robinson, 2005) they are associated. GCSE physics is perhaps best taken as an indicator of whether there is a strong physics presence in a school. Such schools are likely to have a physics department or grouping under its own leader, be more likely to attract well-qualified teachers who wish to specialise, provide children with the opportunity to discover whether they are good at and like physics *per se,* and have vigorous sixth form studies in the subject.

9.4 That is not the whole story however. The demographic dip of about a third in the number of 18-year-olds from 1983 to 1995 will have contributed to the reduction in A-level physics entries during those years. Smithers (1997) showed that only a relatively small proportion of any population, probably less than 10 per cent, is capable of taking and enjoying physics to a high level. As the age cohort came down so will have the numbers studying to a high level subjects like physics, which require particular talents and commitment. However, from 1996 the age cohort has been increasing, but A-level physics entries have continued to fall. Since 1990 the proportion of the age group sitting A-level physics has gone down from 5.9 per cent to 3.9 per cent. This suggests that some very able children capable of contributing to and enjoying physics are slipping through the net. The figures indicate that this is most likely to be happening in those schools that do not offer GCSE physics. This may be because pupils have less chance to identify physics as a subject and decide whether it is for them. But it could also be because science at GCSE is being taught mainly by biologists.

9.5 On the second question, universities have coped with fewer physics applicants by reducing the number of departments and increasing the proportion accepted. Even so, the number of first-year full-time first-degree UK-domiciled students in the 26 universities graded 5*/5 in the 2001 research assessment exercise went down by 8.2 per cent between 1994 and 2004, while in the rest the intake was more than halved. This trend is partly masked by UCAS' and HESA's re-classification of subjects which became operational in 2002 and added a number of students previously recorded under combined studies to the physics box. This has led some to suppose that university entries have held relatively steady.

9.6 Nevertheless, the impact of falling entries in A-level physics on university intake has been ameliorated by a rising pass rate, with the number of A-grades actually increasing since 1990. In line with the better results obtained, the universities have been accepting a higher proportion of applicants. It appears that A-level entries have fallen, in part, because weaker students have selected themselves out before sitting the examination. This has increased since the introduction of the AS as a stepping-stone to A-level since it gives students an early indication of their likely A-level grade. The proportion of firsts awarded in physics has increased markedly since 1997 with corresponding falls in thirds and pass degrees. There could be an element of grade inflation in this, but assuming the universities have striven for consistent standards it does suggest that, at the very least, the quality of the students admitted has not fallen. The proportion of European Union and overseas students has doubled since 1986, but the numbers are still small and the survival of departments still depends very much on their ability to attract UK-domiciled students.

9.7 Only about eight per cent of A-level physics students entering university read physics degrees *per se*. The other 92 per cent spread themselves across the whole spectrum of studies, though mainly in the areas of engineering and technology, maths and computing science, and medicine and dentistry, and the other physical sciences. The proportions going to the various areas has been relatively consistent for the past two decades but with some shift away from the traditional core including physics itself to the creative arts and design, architecture, planning and building, and a wide variety of other subjects and combinations.

9.8 Fewer of the few female students who take A-level physics read physics at university, being much more likely than their male counterparts to take veterinary science, medicine and dentistry, and the biological sciences, and much less likely to take engineering and technology, maths and computing sciences, as well as physics itself. It seems as though subject choices by the sexes are an expression of deep-seated differences. All the students considered here have passed A-level physics, with the female students, on average, obtaining the better results. Yet when it comes to choosing university studies the sexes tend to veer towards the subjects with which they have been traditionally associated.

9.9 Students in independent and grammar schools are more likely to take A-level physics than those in other maintained schools, sixth form colleges and further education colleges. As our survey showed (Smithers and Robinson, 2005) this is associated with teachers better qualified in physics and more opportunity to specialise in physics at GCSE, but it is also true that these schools are selective and have intakes of higher academic ability. Physics is held to be a difficult subject and international comparisons suggest less than ten per cent (as a generous estimate) of an age group have the ability and interest to study it to a high level (Smithers, 1997).

It may be that this is at the heart of the differences between school types. However, the percentage of the age group now taking A-level physics has fallen from 5.9 to 3.9 per cent since 1990 so it seems probable that some who could do well at it and enjoy it have turned to other things. It thus becomes an issue of whether incentives should be put in place in an attempt to staunch the haemorrhage, and it also raises the question of whether there are lessons to be learned from independent and grammar schools.

9.10 These schools attract more than their share of teachers well-qualified in physics. The fall in the number of physics graduates has made it increasingly difficult to recruit the teachers to foster the next generation of physicists. Physics and teaching tend to be associated with different occupational values (Smithers and Hill, 1989). Moreover, in all subjects, women are more likely to be attracted to teaching than men, and they comprise less than one in five of the physics graduates. In consequence, the providers of teacher training have been able to sustain only about a third of the places for physics that they have for biology. Moreover, among those training to teach combined science there are about five times as many biologists as physicists. Science in many schools is, therefore, being taught increasingly by biologists. As we showed in the physics survey, in about a quarter of schools without sixth forms none of the teachers had studied physics to any level at university.

9.11 A vicious spiral seems to have developed. Not enough young people come through to take physics degrees; the pool from which to recruit teachers is not large enough; science teaching is to a greater extent than is desirable left to biologists; many young people do not get sufficient opportunity to discover whether they are good at the subject; they are naturally disinclined to take what they have heard is a difficult subject at A-level when there is an ever-greater range of subjects available; and so there is an insufficient platform to support the university studies to a level where there would be sufficient graduates from whom to recruit the teachers. Grammar and independent schools have generally been able to insulate themselves from some of the more serious consequences by seeking out and recruiting well-qualified teachers and maintaining a curriculum that underpins physics in the sixth form.

9.12 There has been, however, some drift away from physics even in the grammar and independent schools, much less than in the rest of the maintained sector, but occurring nevertheless. The reason could be pragmatic. It could be associated with physics no longer being essential for entry to medical schools. Or it could reflect the evolving nature of the subject. The frontiers of physics have moved on from physical reality to mathematical representation seemingly beyond the bounds of comprehension of many. Or it could be perception and intuition of the demand for physicists. There is clear evidence for a shortage of physics teachers, but what of physicists more generally? The drift from the subject in independent schools should be investigated further since the way forward for many maintained schools might be thought to allow them the same freedoms enjoyed by the independent sector when it comes to science combinations at GCSE.

9.13 The government (HM Treasury, 2006) has recognised that there is an imbalance of specialisms among science teachers and has made it a policy priority to find ways of recruiting more with degrees in physics and chemistry. It is also planning to increase subject-specific continuing professional development. Further, it has recognised that more students progress to A-levels from the separate sciences at GCSE than from the dual-award science, and from September 2008 it is proposed that all pupils achieving at least a Level 6 at Key Stage 3 should have an entitlement to take physics as part of a triple science track. These proposals find support in our research evidence, but will they be achievable? At the same time, there are countervailing pressures to introduce more integrated science GCSEs under the banner of 'Science for the Twenty-First Century' in which physics, chemistry and biology as such will no longer be identifiable (OCR, 2006). These contrasting aims will compete not only for scarce resources, but also for the very definition of school science.

9.14 Physics is in the grip of a long-term downward drift. While it is welcome that the government is alive to the issues, its policies will only become practicable so long as they are grounded in the dynamics of that trend. The government is conscious of the need for more and better information and is advocating that a range of case studies be produced to tease out which school level factors are associated with high levels of progression to post 16 science. The third part of our trio of studies will take a close look at comprehensive schools which buck the trend. But there is also a deep divergence in the views of what is appropriate for school science: is its role primarily to provide a platform for the scientists and technologists of the future, or is it to educate informed citizens who can discuss the moral issues arising from, and influence the politics of, the advance of science and its applications. And if the answer is as it almost certainly will be: both, then how can these different aims best be accommodated within the curriculum and examinations?

9.15 There is an important debate to be had in which the science community should take the initiative. The central questions are: what importance should be attached nationally to identifying and developing students capable of taking physics to a high level, what role should physics play in general education, and how best to achieve the desired ends?

References and Sources

Crossland Circular (1965). Circular 10/65. *The Organisation of Secondary Education*, London: DES.

DES (1978-1984). *Statistics of Education School Leavers CSE and GCSE*. London: HMSO.

GCE and GCSE (Annual Reports). *Inter-Awarding Body Statistics*.

Government Actuaries Department (2006). *Mid-Year Population Estimates*. www.gad.gov.uk.

Graduate Teacher Training Registry (1986-2004). *Annual Reports.* Cheltenham: GTTR www.gttr.ac.uk.

HM Treasury (2006). *Science and Innovation Investment Framework 2004-2014: Next Steps.* London: HMSO.

Higher Education Statistics Agency (Annual Reports). *Students in Higher Education Institutions.*

Higher Education Statistics Agency (Annual Reports). *Destinations of Leavers from Higher Education*.

Institute of Physics (2006). *Physics Policy. Statistics of Physics.* www.iop.org.

Joint Council for the General Certificate of Secondary Education (Annual Reports). *Inter-Group Statistics.*

Kealey, T (2005). 'Science is for posh kids.' *The Spectator*, 5 February 2005.

Lehman, H.C. (1953). *Age and Achievement.* Princeton, New Jersey: Princeton University Press.

Ministry of Education and DES Education in England and Wales (1951-1977). *Reports and Statistics*.

NFER (2006). *Mathematics and Science in Secondary Schools: the Deployment of Teachers and Support Staff to Deliver the Curriculum*. Research Report 708. London: DfES.

Northern Ireland Statistics Research Agency (2006). *General Register Mid-Year Estimates.* www.nisra.gov.uk

OCR (2005). *GCSE Sciences 2006: Awakening the Mind, Stimulating the Imagination*.

PCAS (1985-1992). *Annual Reports.*

Smithers, A. (1997). 'The supply of, and demand for, scientists and engineers', *Save British Science Lecture, ASE Annual Meeting*, University of Birmingham, 2 January 1997. http://www.buckingham.ac.uk/education/research/ceer/archive.html

Smithers, A. and Collings, J. (1981). 'Girls studying science in the sixth form'. In: *The Missing Half* (Ed. Alison Kelly), pp164-179. Manchester: The University Press.

Smithers, A. and Hill, S (1989). 'Recruitment to mathematics and physics teaching: a personality problem?' *Research Papers in Education*, 4, 3-21.

Smithers, A. and Robinson, P. (2005). *Physics in Schools and Colleges: Teacher Deployment and Student Outcomes*. Buckingham: The Carmichael Press.

Smithers, A. and Robinson, P. (2006). *The Paradox of Single-Sex and Coeducational Schooling*. Market Harborough: Headmasters' and Headmistresses' Conference.

Smithers, A. and Tracey, L (2003). *Teacher Qualifications* London: The Sutton Trust.

Training Development Agency (1998-2005). *Performance Profiles.*

UCAS. (1993-2000). *Annual Reports.*

UCAS. (2001-04). www.ucas.ac.uk/figures/index.html.

UCCA (1985-1992). *Annual Reports.*

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