

## The History of Senior Challenge

The Liverpool Mathematical Society (LivMS) was founded in 1899, as a meeting place for grammar school teachers of Maths and University Staff. In 1975, James Taylor came to the University of Liverpool as Professor of Pure Mathematics. From 1973 to 1975 he had been Chairman of the Joint Mathematical Council (JMC) and felt that there was need for greater contact between the University and teachers of Mathematics in local Secondary Schools. He sent round a MEMO inviting all Heads of Maths in Merseyside schools to a meeting at the University. That was the beginning of what became quickly known as Mathematical Education on Merseyside (MEM). This was designed to be independent of the University and to complement the LivMS rather than to replace it. It has for many years enjoyed Charity status.

The first CHALLENGE take-home competition for 12/13-year olds was circulated to schools in May 1978, and the format established then has survived almost unchanged to the present day—the cartoonist, Peter Ackerley, has illustrated every paper from then until now. His logo for MEM of a planet orbiting a cube bearing the letters M E M provided the name of the termly newsletter the MEM Orbiter, which now has a circulation of over 1000.

The annual CHALLENGE, advertised in the January edition of the MEM Orbiter, consists of a single A4 sheet, carrying 6 puzzles of varying difficulty. One copy of CHALLENGE gets sent to each school for them to copy to anyone interested. It is attempted during the mid-term holiday week in February. The best 100 or so entries receive an invitation to an evening of Mathematical Recreation at the University of Liverpool, some time in May. Activities now include a box of the FunMaths Roadshow of the Liverpool Mathematical Society and a poster trail consisting of 12 posters each carrying a simple question with answer an integer between 1 and 49, with the answer to one of the other questions at the top of each sheet, so that they form a chain. These are randomly distributed in rooms that otherwise could not usefully be used, and competitors have to complete the chain of answers in the correct order. Besides this there is a timed twenty questions quiz in the Computer Teaching Centre. Also there is shop selling mathematical books and toys, known as Joyce's Shop, in memory of Joyce Hatton of Bolton, who created the shop and took it to many venues over many years.

Demand from children led to adding SENIOR CHALLENGE, aimed at Years 9 and 10, the first issue being in 1980. It also is attempted during the mid-term holiday week in February. As with CHALLENGE, the best entries receive an invitation to an evening of Mathematical Recreation at the University of Liverpool, some time in May, the arrangements then being very similar to those for CHALLENGE as detailed above.

It was not long afterwards that the existing LivMS take-home competition for sixth-formers became OPEN CHALLENGE, though still produced by the LivMS rather than

by MEM. One copy of OPEN CHALLENGE gets sent to each school for them to copy to anyone interested.

Several years of CHALLENGE and SENIOR CHALLENGE have previously been printed in facsimile form in house, while many of the puzzles from CHALLENGE were published in 1990 by Oxford University Press (reprinted 1992 and 1994) and an American edition of some of the Senior Challenge problems was published by Janson Publications in 1989. The OUP edition was even translated into Polish and published in Poland.

This compilation contains edited versions of all the question papers from 1980 to 2003, together with newly produced full solutions and appropriate commentary for some questions. The original Peter Ackerley cartoons, which convey so much the style of the competition, are reproduced alongside the questions.

## **A Guide to the Questions**

Senior Challenge questions are designed to test and foster mathematical thinking. Many of them can be approached by an intelligent ‘trial and improvement’, while yielding also to a more sophisticated algebraic approach. Many are dependent on logical thinking only, or spotting a pattern from some examples. Each year’s competition contains a great variety of questions, in general getting just a little more demanding from Question 1 onwards. In the early years, the last Question is often very demanding. In more recent years, however, we have tried to broaden the appeal of the competition by including a larger proportion of ‘easy’ questions at the beginning, and generally making all the questions more widely accessible. To what extent we have succeeded we leave you to judge!

Senior Challenge has always been aimed at Years 9 and 10. Naturally some topics come and go from syllabuses, and there remain some questions which use ideas not generally taught at this level any more, such as similar triangles and basic trigonometry. The solutions provided are very detailed, and wherever possible they have avoided ‘forbidden’ topics—good old Pythagoras’s theorem can work wonders, and it is used a great deal in the geometrical questions! Solutions tend to use algebra rather than trial and improvement, or plain guesswork, and sometimes they hint at more advanced matters which the question conjures up.

We list below the questions which still seem to need ‘more advanced’ topics for a proper solution. We hope that this might prove useful in issuing due warnings. The following on the other hand are regarded as fair game: square roots, basic angles including clock hands, Pythagoras’s theorem, areas of triangles, circles and fractions of circles in terms of  $\pi$ , ratios, graphs (only drawn by points, or with a graphical calculator!), highest common factor of two numbers, calendar dates, relationship between time, distance and speed, powers of numbers, percentages.

Abbreviations: TN = trigonometry needed; TA = trigonometry can be used but an alternative is given in the solution.

- 81-6 Centre of gravity.
- 83-5 TA
- 85-4 TA
- 87-6 TN for part of the question.
- 88-2 Similar triangles; also the quadratic formula.
- 88-6 Similar triangles are used but most of the question can be done without them.
- 89-5 Solution given uses graph of distance against time being straight for constant speed.
- 89-6 TN
- 90-3 Relative speed.
- 90-4 TN (but only for the easy angle of  $30^\circ$ ).
- 90-6 TN (again just for  $30^\circ$ ).
- 91-6 TN (area of a triangle =  $\frac{1}{2} ab \sin \theta$ ); quadratic formula, though factorization is mainly needed.
- 95-6 TN (area of a circular sector with given angle).
- 96-6 Quadratic formula.
- 02-4 Quadratic formula, though a few trials will also do.