UNIVERSITY OF LONDON INSTITUTE OF COMPUTER SCIENCE
M.Sc. PROJECT REPORT

A CRITICAL SURVEY OF COMPUTER EDUCATION IN SCHOOLS IN THE LONDON BOROUGH OF HAVERING.

MILDRED L.G. SHAW

SEPTEMBER 1972

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U.L.I.C.S.
September, 1972.

ABSTRACT

The aim of this project was to carry out an investigation into the computer education in schools done in the London Borough of Havering. This authority was chosen because, as a result of its forward looking ideas, it was the first to have a computer in a school.

The present work, facilities and situation were surveyed and possible suggestions made for the future.

INTRODUCTION TO COMPUTER EDUCATION IN SCHOOLS

The use of computers in schools can be divided into three main categories: teaching about computers, computer assisted instruction, and administration. At the present time the most extensive use is in the teaching of computer studies, including programming, to children of secondary age. One type of course commonly offered to thirteen to fifteen year olds of all abilities is the general appreciation course. This is intended to introduce the subject of computers and give the children some idea of how they work, what they can do, what they are most often used for, and how they will affect us all in the future.

Another type of course in schools is mainly concerned with programming. The children are taught flowcharting, usually by the mathematics department, and then a programming language which enables them to use thecomputer to solve their mathematical problems. This is especially popular in sixth form studies. Unfortunately, few people realise that computer science is not a branch of mathematics. The mathematician uses the computer as a tool, just as he uses a slide rule or a calculating machine, and naturally when he teaches programming, he takes exampleswith which he is most familiar.

A happy compromise is a combination of these two aspects of computer studies. Certain manufacturers and other bodies produce packages of material to help the teacher to plan and present his course. These often consist of film strips or slides, pupils' books, workbooks, and teachers' books, and are designed with a specific age group and ability range in mind.

All children and adults should know something about computers and their uses in society. This is part of a child's general education and can be taught by teachers of any background. An appreciation course should not necessarily lead to an examination, but should equip the children to understand computers as they come across them in their everyday lives. The length of the course might vary according to the age of the children and the time available, but should include at least some of the following concepts. Firstly, it must be realised that the main commercial use of computers is in the

field of data processing. A study of this could include the history and development of calculating devices, the organisation of information and the communication of ideas. It is important to know about the basic structure of a computer, that is the five main components and their contribution to the storage and execution of an instruction, and problem solving by the use of algorithms and procedures. If possible the children should write and run simple programs of their own. They must also know something of the applications of computers in industry and commerce, data banks and information storage and retrieval. If further time is available, then work with older children could progress to include applications of computers to statistics, numerical methods and analysis, operational research, and systems analysis and design.

When considering computing facilities, costs must naturally be borne in mind. There are three main possibilities for schools: using an on-line terminal connected to a large central computer via post office telephone lines, buying time on another computer system such as a bureau, or owning your own computer either new or second hand. The use of an on-line terminal would involve the purchase of the terminal, the cost of telephone calls and rental of disc storage. This is quite economical for use on a small scale. Although capital expenditure is reduced using a computer belonging to someone else, it is very difficult to cost the use of a bureau facility. There are several disadvantages some of which apply also to the use of the computer at the local town hall. One of these is always having low priority, and so a slow turnround of jobs. This is especially irksome for the correction of errors. Again, bureaux tend to change their systems quite frequently which means discontinuity, and they operate on a tightly controlled timetable which is difficult for schools. To purchase your own computer requires more capital expenditure, but has a number of advantages. It can be organised to suit yourself with almost instant turnround, a flexible timetable, and greater understanding by the children through operating the machine and running their own programs. Second hand computers are much cheaper to buy than new ones but the running costs are often very high in comparison.

Another use of computers in all levels of education is

computer-assisted instruction known as CAI. The computer may be used by individual students or a group of students for learning in a variety of modes. Up to now, most of this work has been experimental, but if technological development continues at its present rate, it cannot fail to have a far-reaching effect in the near future.

The reason that CAI is so desirable is based on the advantage of individual instruction. For many centuries the efficacy of this method has been demonstrated by the aristocracy, who were educated by tutors, and who at university level had the benefit of tutorial instruction at Oxford and Cambridge. Criticisms of this method are made for purely economic reasons, and are not directed at the method itself. The computer can be programmed to adapt to individual learners, each of whom has his own unique style of learning, record his successes and failures, and use these records as a basis for the selection of further material.

The most commonly used device is an on-line terminal. In many cases this is just a keyboard with input and output being typed on to a roll of paper, but a device which is now being used extensively is a cathode ray tube. This is like a television screen attached to the terminal onto which messages can be generated directly by the computer; the student can also have a light pen with which he can touch the screen to input his answer instead of typing on the keyboard. This is especially useful for young children who sometimes have difficulty in typing a reply correctly. Another useful addition to a terminal is a sound device which can present spoken information or comments at appropriate points. For young children who may have difficulty in reading, this is sometimes essential for their understanding. Computer generated films and a computer operated slide projector are also extremely helpful at all levels.

The other major use of computers in education is in administration. Previously, it was extremely difficult to collect and store systematic data on how children were progressing in all subjects. Now however, a computer can be used to collect the data from certain tests, store it, correlate it with that from other tests, and use the results to give an indication of the progress of each child. The computer can

easily be used to show up individual difficulties which might help in the revision and improvement of the curriculum or school text books. It can also be used to give references to information on any subject for use in the preparation of courses and lessons, or the cataloguing of books in the library.

In the near future computers will almost certainly be used to solve the school timetabling problem. At the present time there are two systems in operation: Nor-Data, which is a Norwegian service where the school fills in a set of forms about subject options, teachers available, rooms available with alternatives if necessary, the size of each group and other relevant information which is sent away to be processed; and a scheme based on the work done by Dr. Charles Kent in New Zealand which is a FORTRAN program that Dr. Kent is currently attempting to market in this country. The first scheme produces at least 98% success but this can be improved by finishing the process with a certain amount of hand coding. The second scheme is more of a do-it-yourself package where data is presented in a more straightforward manner, and it is possible to interact with the computer to remove certain restraints after an initial attempt so that greater success can be achieved on a second run.

The use of computers in schools is at the moment mainly restricted to the teaching of computer studies, either computer appreciation or programming or a combination of the two. Some research is being done on CAI and programs are being used mainly in mathematics, geography, biology, economics and the teaching of a second language. Computers in administration is also undergoing research, but its application at present seems to be restricted to the calculation of teachers' salaries.

In the near future it is hoped that computer science will be a subject in its own right on the timetable with applications and uses in all other subjects. The difficulty at the moment is that too few people realise the need for computer education. There are schools with enthusiastic teachers all over the country, and some local authorities are very keen, but insufficient support and co-ordination is being offered from the Department of Education and Science and the Schools

Council at present. Scotland is extremely fortunate in having the Bellis report "Computers and the Schools", but the rest of Great Britain is sadly lagging behind.

INTRODUCTION TO THE ROYAL LIBERTY SCHOOL

The Royal Liberty School, Romford, is a maintained grammar school under the authority of the London Borough of Havering Education Committee where in September 1962 Mr. W.R. Broderick took up his first teaching appointment as a teacher of mathematics. Mr. Broderick had already shown an interest in teaching computer programming in school during his teaching practicewhen he had taught programming to a group of sixth form students, and within a short time was able to continue this work at the Royal Liberty.

He was convinced that computer education in schools was a feasible proposition and a meeting was held at the headquarters of ICT (now ICL) in January 1963 for teachers and the training department of the company. It was felt by some that the subject should be left to the companies themselves and not introduced at school level. The teachers were enthusiastic but wanted the opportunity to find out more about computers and programming. A half day course on programming and numerical analysis was held shortly afterwards to estimate the demand and requirements for similar holiday courses lasting several days. It was thought necessary at this stage to consider practical computing facilities, and the possibility of the school owning a computer was one of many suggestions. This was obviously desirable and would cut out the need to use university or borough administration machines.

Full support was given by the headmaster, Mr. J.P. Coles which meant that Mr. Broderick was able to begin considering what would be a suitable computer for use in school. A sum of £15,000-£16,000 was estimated as being necessary to cover the cost of purchasing the computer and other essential equipment. It was decided that an outright purchase was more desirable than renting, especially from the point of view of the financial support expected from outside sources.

Before approaching the Romford Education Committee for financial help a considerable time was spent in formulating ideas and proposals in a detailed report. Due to the forthcoming reorganisation of County Boroughs and possible restriction on expenditure, it was not considered possible to allocate a sum of money for the purchase of a computer.

The next step involved approaching a local firm and other major trusts with educational interests. Over the months various ammounts were donated including a generous grant from the newly formed London Borough of Havering who were willing to pay for the running of the computer.

After careful consideration of various types of computer it was finally decided that the newly available Elliott 903 was the most suitable for the purpose.

It was necessary to consider possible 'A' level courses and syllabuses in addition to the obviously important task of finance. Although the ideal was a complete course for an 'A' level examination in computer science, the time required to obtain approval from the various committees made it impracticable and a compromise was adopted — namely a mathematics syllabus including the solution of various problems by computer and by numerical methods. The syllabus is reproduced in Appendix 1. No one language is specified which means that the choice falls on the particular school. The Royal Liberty School decided to adopt ALGOL which was thought to be a suitable high level language for programming of a mathematical nature.

Difficulties arose in finding sufficient space to house the computer : not only in finding the actual floor space but the special requirements of a computer laboratory. It was necessary to choose somewhere isolated from the school classrooms to prevent disturbance by the computer in operation. The site needed to be accessible from the outside, to make removal of equipment and maintenance a workable proposition. At the same time a ground floor area would have to be chosen to take the considerable weight of the computer. These three factors meant that there was very little choice, and eventually an old cloakroom was found which was ideal although the alterations and modernisations were more than negligible.

The Elliott 903 was on order and due to be delivered in the early part of 1966. The Elliott Automaton Company offered to lend an Elliott 920A computer for the time until the 903 was available, but it had not arrived by the time school opened in September 1965. Nevertheless three computing courses were begun. The first was the two year GCE 'A' level course in mathematics taken by a group of sixth form boys. The others

were courses in computer appreciation including how computers work and their various applications.

In October 1965 the Elliott 920A computer arrived and in a very short time was being used widely by many enthusiastic pupils in the school. It was thought desirable that sixth formers from other schools in the borough should have the opportunity to have an insight into the scope of computers and consequently a course was arranged. Although this was a good idea in itself it was even more vital for school staff to be in a position to do the teaching themselves so that the subject could be included in the timetable.

Difficulties were experienced in the early months due to the unavailability of the ALGOL compiler for the Elliott 903 especially for students taking forthcoming examinations.

The first of the four day courses for teachers was held during school holidays and was very well attended. Despite the necessity for a program messenger service to Borehamwood a large number of programs were written and it was felt that a great deal had been achieved. Other courses were arranged during this time but the increase in productivity after May 1966 when the new ALGOL compiler was in use was noticable to say the least. It took several months to remove certain faults which at first seemed to be serious and it was not until July of that year that the staff and students at the Royal Liberty School could use the computer with any certainty of success. Shortly afterwards further teachers courses were arranged: an advanced ALGOL programming course as a follow up to the previous introductory one; and a second four day introductory course. The response and enthusiasm shown by teachers from the London Borough of Havering and outside encouraged the organisers and lecturers to consider courses in other programming languages, and in January 1968 a four day course in the assembly language SIR was run. This was followed shortly afterwards by a similar course in FORTRAN.

THE GENERAL SITUATION AT THE COMPUTER CENTRE

In the ten years since this work was started, a great deal has changed. Instead of the Elliott 903 which was eventually installed permanently in March 1966, there is now a Hewlett Packard 2116C; instead of treating computing as a subset of mathematics to be used only as a tool in obtaining an answer, it is now recognised to be a subject in its own right with applications in all other school subjects; instead of teaching only grammar school pupils, all secondary schools have access to the facilities; and more changes may occur when the computer department vacates the premises at the Royal Liberty School to go to its own building in the near future.

The present computer laboratory was adapted from a spare cloakroom in the old part of the school. It is on the ground floor, adjacent to the main entrance, and sufficiently far from the main block of classrooms to interfere in any way with the normal activities of the school, either with the noise generated by the computer and teletypes, the installation of equipment or the passage of visitors. The computer room is divided into three parts. The partitions are made of wood up to waist height and double-glazed above this to help to reduce the noise. This has the double advantage of being able to see everything that is taking place and making the room light and airy. The whole area is approximately 30 feet by 20 feet, and about a third is given up to the computer area. This holds the computer, teletypes, cardreader and is sufficient space for ten to fifteen students to work or watch a demonstration quite easily. There is also a filing cabinet holding library programs, discs and other necessary equipment.

From the remaining part about a third is used for an administrative office, and the rest for two secretaries, and two people working with the computer. In another small room are the punch operators who punch programs for schools and courses. A classroom approximately 30 feet square is available across the corridor with three more teletypes and an on-line time-sharing terminal to a Honeywell G 615 computer.

In April or May each year, schools are invited to submit bookings for the computer for the following academic year, any clashes of bookings being resolved by negotiation. After

the timetable has been drawn up, transport arrangements are made for the schools which require them. For the academic year 1972-1973 three plans for the provision of computing facilities are being considered, one of which will be implemented.

Plan A — is to carry on next year in the same way as in the past with groups of students visiting the computer centre with a teacher.

Plan B — is a choice for schools either to carry on as in the past or to use a courier service calling at the school twice daily with occasional visits to the computer centre.

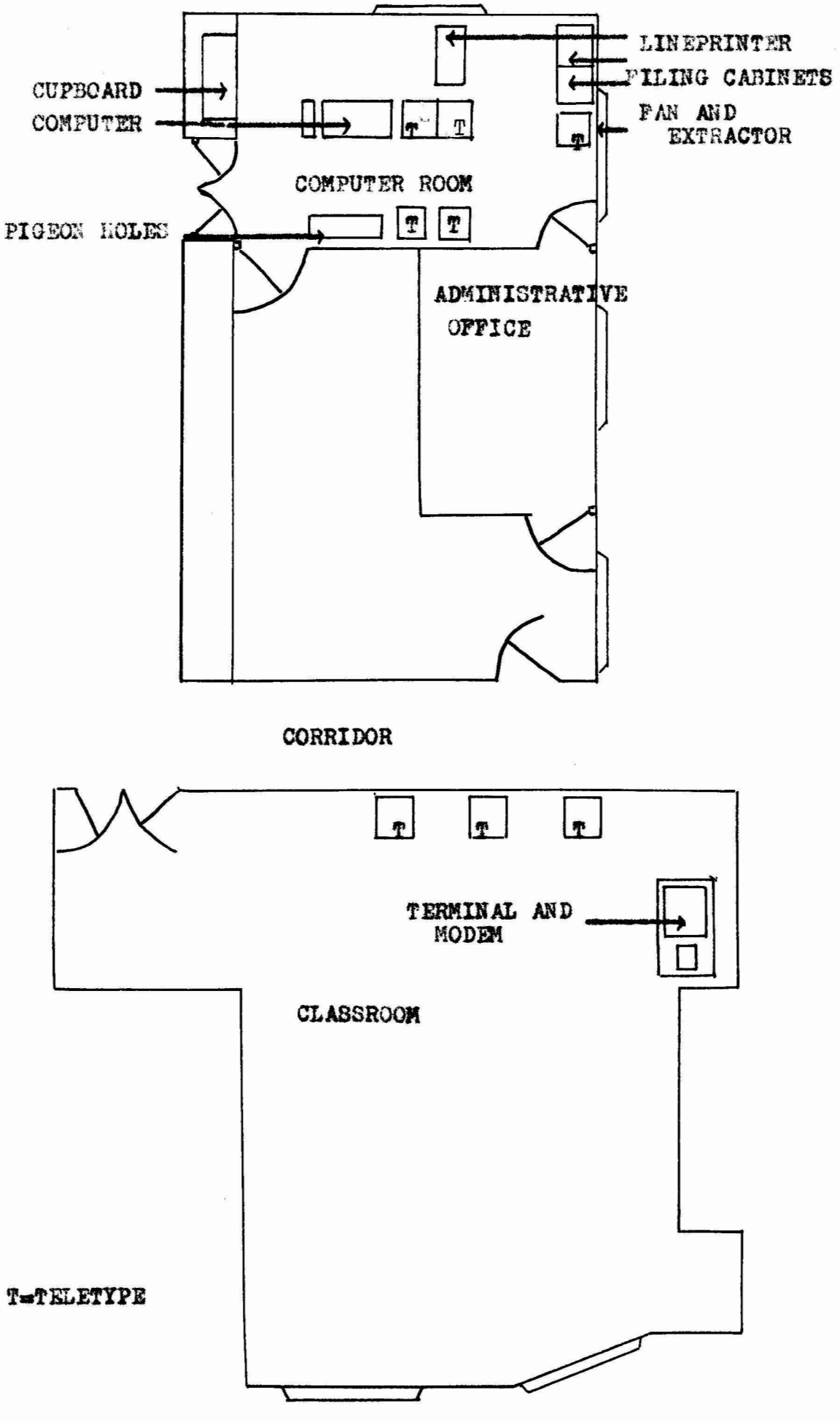
Plan C — is for some schools to have the time-sharing terminal for half or one day per week in school. According to demand, there may be restrictions on the use of the terminal.

A questionaire has been sent out to schools for their opinions of these plans, and on the basis of the replies one will be chosen.

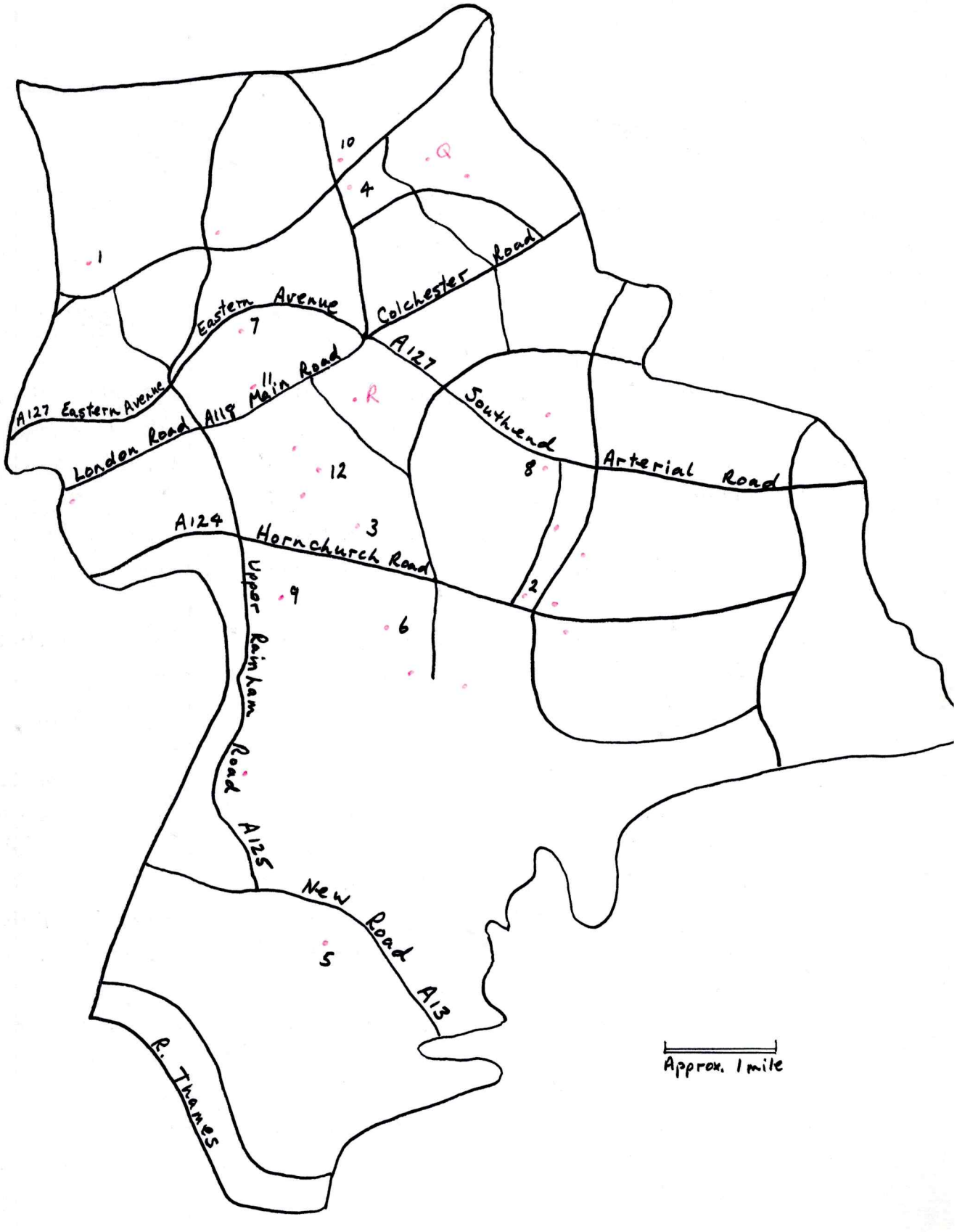
Every month a newsletter is sent out to each school containing information such as news of courses and meetings about to take place, amendments to library programs, and new publications of books and pamphlets.

In the past most schools have chosen to program in ALGOL as this was the most satisfactory language to use on the Elliott. Some also taught the assembly language SIR, and some FORTRAN. Since the change of machine however, BASIC is the easiest language to use and is superior in many ways as a teaching language. Without exception, schools have now changed to programming in BASIC.

THE ROYAL LIBERTY SCHOOL COMPUTER DEPARTMENT



THE LONDON BOROUGH OF HAVERING



DISTANCE IN MILES	NUMBER OF SCHOOLS			
	R		Q	
UNDER 1	1	1	1	1
1 — 1½	1 1 1	3		0
1½ — 2	1 1 1 1 1 1	6	1 1	2
2 — 2½	1 1	2		0
2½ — 3	1 1 1 1	4	1 1	2
3 — 3½	1 1	2	1 1 1	3
3½ — 4	1 1 1	3	1 1 1	3
4 — 4½	1	1	1 1 1	3
4½ — 5	1 1 1	3	1 1	2
5 — 5½		0	1 1 1 1 1 1	6
5½ — 6		0	1	1
6 — 6½		0	1	1
6½ — 7	1	1		0
OVER 7		0	1 1	2

The London Borough of Havering is one of the largest of the twenty Greater London Boroughs formed in 1965 and is situated in the north-east bordered by Essex on the east and the river Thames on the south.

There are twenty-seven secondary schools comprising two mixed technical high schools, five grammar — two mixed, two boys' and one girls', one mixed comprehensive, three girls' and one boys' secondary modern and the others are mixed secondary modern schools. These accommodate over 17,000 children of secondary school age.

Recently plans for reorganisation of secondary education have been submitted to the secretary of state for Education and Science with a view to introducing a variety of comprehensive schools to replace the existing grammar, technical and secondary moderns. This was to be carried out by combining schools in the same vicinity, the resulting comprehensive to admit the full ability range at eleven years. Although the major part of the scheme submitted to the secretary of state has been accepted, certain interim proposals have had to be reconsidered and it is hoped that the completed scheme may be introduced in its initial stages by September 1973.

Most of the new schools will accept both boys and girls but there will be the opportunity for parents to select a single sex comprehensive if this is preferable to them.

The map of the London Borough of Havering shows the positions of the secondary schools in relation to the current site of the computer centre, R, and the new site, Q, in the north of the area. Each secondary school is shown by a red dot, and those using the facilities at the computer centre are numbered. It can be seen that the distance to Q from the majority of schools is considerably more than from R which would mean an increase in the travelling time and cost for the carrying out of practical work. A comparison of the distances from the two sites is made and the mean milage class from R and Q is found to be 2½ — 3 miles and 4 — 4½ miles respectively.

VISITS TO SCHOOLS

SCHOOL 1

This is a comprehensive school with over twelve hundred pupils. They teach computer appreciation to the entire third year as part of their mathematics course. These children are streamed into eight classes, and the approach varies according to the ability of the children. They are split into half classes to visit the computer centre, each half class having three visits. During these they look at the computer, noting various parts, run pre-prepared programs and punch pieces of tape each. Some of the top classes make up their own simple programs from statements given to them. They are shown the time-sharing link with an explanation of the system and are able to access and use a filed program of the question and answer type. In between their visits, they have one or two lessons about computersand their uses in society. They are also told a little about the computer, the five main parts, and how an instruction is executed.

The sixth form general studies includes an option on computing which is usually chosen only by members of the 'A' level mathematics group. They have two lessons a week for half the year in school on BASIC programming and are able to visit the computer centre one day a week after school. Also at this time members of the computer club, which is open to any pupil in the third year and above, go to the computer centre. They can then run programs which they have previously written and sent for punching.

There are eight members of staff who are interested in this subject. Some have been on courses at the Royal Liberty, one did 'A' level mathematics with computing at school and one has been following a course at a technical college. At present four are involved in teaching it, all belonging to the mathematics department.

COMMENT

The course for the third years is well balanced and well organised in general. Previously it has been left very much to the teacher'sdiscretion what topics are included, but now a syllabus is being discussed and drawn up.

Two of the staff are concerned in a project with teachers from other schools to produce a package for students in the ROSLA (i.e. raising of the school leaving age) scheme. This will include a large section on the commercial and industrial uses of computers in banking, hospitals, the home, highway design and other aspects of everyday life. A film has been made showing examples of all these uses of computers.

SCHOOL 2

This is a secondary modern school with almost six hundred pupils. Computer studies was first offered as a CSE Mode 3 option for fourth years in 1970. It had a marked success and its popularity is steadily growing. One double lesson a week is allowed in school for this, and one double lesson at the computer centre once a fortnight. Because of the change of machine, BASIC is now taught exclusively, although an assembly language may be included in the future. A syllabus, scheme of the distribution of marks and specimen examination paper are included in Appendix 1.

There are two members of staff able to teach this work but only one is doing so at present. They are both from the mathematics department and have been on courses at the Royal Liberty School. In addition, one has followed an Open University course.

COMMENT

This year there was an initial timetabling difficulty and some lessons were run out of school time with the result that some of the fifth year pupils dropped the subject, but there is a strong group of twelve fourth years who are continuing with interest. Next year it is expected that thirty fourth years will start computer studies, most of whom will take the CSE examination in 1974. During this experimental period the syllabus is being modified and amplified. At the moment at least half the time is given to programming. A wide variety of programs are written, not just ones of a mathematical nature.

The member of staff concerned is very enthusiastic and is one of those involved in producing the package for the students in the ROSLA scheme described in the account of school 1.

SCHOOL 3

This is a secondary modern school of nearly six hundred pupils which offers CSE courses in the fourth and fifth years, and 'O' level subjects in a one year sixth form course.

The mathematics 'O' level option is allocated eight lessons per week, some of these are set aside for computer studies, one or two in school and a double at the computer centre. Almost all of this is programming and is used to help the students with their mathematics. The teacher in charge believes that the students should experience everything themselves so that they have a thorough knowledge of each stage of programming. This means that they write the programs, punch them on to tape and run them, making corrections or alterations on-line as necessary.

COMMENT

This year there have been eight students in the group which is an ideal number for this sort of work. At present computer studies is no part of their examination but it is possible that in the future a CSE course may be offered in the fourth and fifth years. When I saw the class at the computer centre they were using standard functions to obtain answers to mathematical problems. They were working steadily but I did not see any burning enthusiasm, which is to be expected with this type of child.

There is only one member of staff interested in this work, the head of the mathematics department, who has been on many courses held at the Royal Liberty School and is very enthusiastic. Perhaps much of this enthusiasm was initially inspired by his son who is a specialist in computer science.

SCHOOL 4

This is a grammar school of five hundred pupils. Here, computer studies is an option in the sixth form general studies course. Two groups are run, one for beginners — mainly first year sixth — which is entirely programming, and a continuation course for students who want to carry on for another year. Each group has one session a week in school for half the year and a two hour session after school at the computer centre. This year there were fifteen in the beginners course and five in the continuation course. The latter includes, in addition to programming, some investigation into the applications of computers in commerce. There are six members of staff who have been on courses at the Royal Liberty from the mathematics and science departments, one has in addition attended an open university course. However, only two are concerned with this work at present.

COMMENT

These students start with BASIC programming, usually to solve mathematical problems, but soon progress to solving problems concerned with their own interests, such as physics practical calculations, or adding harmony to a melody. After this they may go on to ALGOL or FORTRAN programming.

The two members of staff concerned are very enthusiastic and have for several years helped in the organisation and lecturing of the courses run for teachers at the computer centre. In addition to this, one is concerned with the ROSLA package mentioned in the account of school 1. It is unfortunate that with all this ability and enthusiasm, there is no time available for work to be done lower in the school.

SCHOOL 5

This is a rapidly expanding secondary modern school of over six hundred pupils, and this is the first year that any computer studies has been offered in the school. Last summer holiday six members of staff, mainly from the mathematics department, attended a course at the computer centre on BASIC programming and in September a pilot scheme was started with a top second year class. Because of their situation (see map) they have had the use of the time-sharing terminal for one day each week. Difficulties were experienced using one terminal with thirty-six children, and experiments were tried using acetate in the terminal, to be fed onto an overhead projector. Unfortunately the acetate would not take the printing and this has so far proved unsuccessful. It was therefore decided to use the punching service for this class instead of the terminal.

Since then the terminal has been used mainly for the sixth form 'A' level mathematics groups. They have found programming helpful in solving some of their problems especially those of a trigonometrical nature where graphs could quickly be plotted by the computer.

The terminal is not collected until 6.15 p.m. so can be used for the computer club held from 4.00 to 6.00 p.m. on that day. Any member of the school may join or leave when he or she wishes. They are organised into small groups of equal experience so that they can learn together and have appropriate help in groups or individually where necessary. There is also a teletype permanently installed enabling tape to be pre-prepared.

COMMENT

This school is in a poor area and has a large turnover of staff. However, the efforts and enthusiasm shown by the headmaster and senior members of staff are reflected in the work and interest of the children, and the marvellous atmosphere in the school. When this experiment was started, it was decided to allocate one lesson per week to the second year class. They were initially told a little about the computer and how instuctions are stored and executed, but the major part of the time was devoted to programming. By Christmas, due to the restricted experience of the staff, it was thought that all likely programs suitable for these children had been exhausted, since they had limited mathematical knowledge and ability. However, it was soon realised that programs of a non-mathematical type were well suited.

Later in the course the emphasis was changed from programming to computer appreciation. It is thought that in future years this will form the basis of the course from the beginning with programming taking a less prominent part.

The sixth year students were very disappointed and disillusioned when they discovered that the computer did not produce the answer to an integration, for example, without some hard work on their part. This shows up the misconceptions held by many people, both children and adults, about the capabilities of computers, and clearly makes the point that this sort of work is well worthwhile. As the staff and students were gaining experience together, progress was slower than would be expected in the future. Maybe for this reason, or maybe because the students found programming lengthy for results they could get more easily by hand, interest waned half way through the year. As the sixth form is rapidly expanding, and the school is soon to become comprehensive, this is not likely to happen again.

In September, a two year CSE course in computer studies is being offered as an option to fourth years. It has proved very popular in the list of choices. It will be taught by a member of the science department and will be based on the ICL CES 16- scheme.

SCHOOL 6

This is a technical high school of about eight hundred pupils. There is no computer studies on the timetable here, but the head of mathematics runs a club for children interested in programming. Each week the club, with thirty-two children from the second and third years, meets in the dinner hour. They are taught in a heuristic way; a program is put on the board for the children to read and copy. These are then sent for punching, and later in the week two visits are made to the computer centre, each time half the group going, when they run their programs, investigate what happens then correct or amend them. Suggestions are made for alterations and improvements which can be later incorporated. Each week a different statement is introduced or revised, gradually building up the vocabulary of each child.

Using this method of teaching, although programs of a mathematical type are mainly used, the children with good verbal ability progress most rapidly. The third years who are attending the club for the second year are able to write their own programs with help when required.

COMMENT

I was able to see a group visiting the computer centre. They were very keen and hardworking, quickly finding new things to try in their programs. If one of the thirty-two drops out of the club, there are many more anxious to take the place. Some of them who have other commitments in the dinner hour are sufficiently enthusiastic to copy the program at another time.

Next year, in addition to the club, a fourth year course is starting for people who do commercial arithmetic instead of mathematics. It is an ICL CES 16- package which will include a fortnightly visit to the computer centre. At present it will not be associated with an examination, although in the future a CSE course may be offered.

The member of staff concerned has attended several courses at the computer centre. There is no-one else on the staff able to help with this work but it is hoped that this will alter in the near future.

SCHOOL 7

This secondary modern school of over six hundred pupils allows one session of an hour and a quarter each week on the timetable for computer studies. Last year this was offered as a fourth year option for a limited number of thirty pupils from all classes. This year the same pupils have continued into the fifth year. They all spend the whole session at the computer centre, half writing programs in the classroom, the others running programs on the computer. Some difficulty was experienced with the change of machine early in the year and less was achieved than expected.

No computer appreciation is covered as such but the careers staff arrange visits to local installations for all fourth years.

The head of the mathematics department runs this group alone. He has been on a programming course and also a general course on computers both at the computer centre. There are two other members of staff who have been on courses at the computer centre but who do not at present teach computer studies.

COMMENT

It is interesting to see that computer studies is run as a course apart from mathematics. This has the advantage that children who are less able mathematically need not feel an immediate dislike of the subject. Unfortunately, it has the disadvantage that extra time cannot be 'borrowed' from mathematics, and one and a quarter hours per week is really insufficient for teaching prior to each practical session.

Next year the visits to the computer centre will be after school time. One hopes that the interest of the secondary modern fourth year pupil will not lessen because of this.

Some programs written by children are in Appendix 2. These were written previously when the Elliott machine was in use. This school now uses BASIC instead of ALGOL.

SCHOOL 8

This is a boys' grammar school of over six hundred pupils. In the past courses have been run for the sixth form mathematics group in ALGOL, FORTRAN and SIR, including regular visits to the computer centre. Two years ago some sixth formers studying for a variety of other subjects took the Royal Liberty School parallel 'A' level examination but this was not thought to be successful and was not repeated. This year, although time was allowed for a visit to the computer centre, no transport was ordered, so the time was not fully used.

There are several of the staff interested in computer work, mainly having been to courses at the computer centre and one had followed a course at college.

The sixth form have mainly used computing as a tool in mathematics, to solve problems connected with such topics as matrices, series and statistics.

COMMENT

This year very little computer studies has been done. This coming year a course is being run for the lower sixth general studies as an option. This will involve the use of the on-line time-sharing terminal for half a day per week, and fourteen students of all interests have opted to do the course. Unfortunately the terminal cannot be used until another GPO telephone line is installed.

In addition some computer studies will be incorporated into the third year mathematics syllabus. These children will be taught BASIC, and will send their programs by courier to the computer centre to be punched and run. This programming knowledge will subsequently be used in their mathematics course to help them in solving problems.

The new school year started here at the beginning of July, which has the advantage that this stretch of time is fully used. A disadvantage in this arrangement is that the person who will be doing most of the computer studies in September is not yet on the staff. Hence another member of the mathematics department is using the intervening time to teach some computer appreciation to the sixth form group.

The person who has been mostly concerned with the computer studies in the past will not be teaching the subject this coming year, but has for several years been one of the lecturers on the teachers' courses at the computer centre and will continue to do this work in the future.

SCHOOL 9

This a girls' secondary modern school with over four hundred pupils. They have the on-line time-sharing terminal for one afternoon a week, and computer studies is taught to the top two mathematics sets in the third year one lesson being taken from their mathematics time for teaching BASIC and writng programs which are then sent to the computer centre for punching. In addition to this, each girl who wishes has the opportunity of using the terminal once every three weeks for running programs and making corrections on-line. Almost all the programs written are concerned with mathematics.

There is only one member of staff involved with this work, although another is willing to supervise the use of the terminal occasionally.

COMMENT

On the day I saw this school using the terminal some difficulty was experienced in making contact with the computer, and the first half hour was wasted. However, the member of staff was able to run the programs later.

Next year computer studies will be timetabled in its own right so that children are not deprived of valuable mathematics time. It is hoped that the present third years may be able to continue their work next year in addition to this course being repeated with future third year classes.

The person in charge has been on a BASIC course at the computer centre and had previously been taught FORTRAN programming at college as part of the mathematics course.

SCHOOL 10

This is a secondary modern school of nearly seven hundred pupils. Computer studies is incorporated into the mathematics course of the two parallel top third year classes. One lesson a week in school is devoted to programming and each child is able to visit the computer centre at least every six weeks. They write programs mainly of a mathematical nature.

There are two members of staff involved, both from the mathematics department, and both having been to courses at the computer centre.

COMMENT

These children mainly copy programs from the blackboard, as they seem to have some difficulty in thinking algorithmically in order to write their own. I talked to one of these classes and asked them for their comments on the work they had done this year. With only two exceptions every child had enjoyed the work and found it worthwhile. Some were very enthusiastic. They thought that once every six weeks was too infrequent for running programs but when it was pointed out that twelve was as large a number as could be accommodated they agreed that it would be impossibe with more. The obvious answer to this is that more time should be allowed on the timetable.

This group uses mark sensed cards and the other group sends programs to the computer centre to be punched. There are advantages and disadvantages in both methods, neither seeming superior to the other.

SCHOOL 11

This is a technical school of over seven hundred pupils. Computer studies is run as an option for the sixth form general studies. They have three lessons a week in school and an hour a week at the computer centre after school. Only programming is tackled in this course, most of the programs being of a mathematical type or concerned with games such as noughts and crosses.

A club is run for the rest of the school once or twice a week in the dinner hour. The largest group attending are first years with a few seconds and thirds. They also have a session at the computer centre, up to an hour and a half a week. These children write a variety of programs, mainly investigations of their own choosing.

There are two people involved with computer studies, both having had some programming experience before coming to the school.

COMMENT

In the sixth form group this year there are eight students all from the first year, all boys, and all taking 'A' level mathematics. This seems to be the trend each year which is unfortunate as it gives the other students a false impression of the purpose of the course.

I was able to see the younger children on a visit to the computer centre. They were very enthusiastic and had a lot of ideas for new programs and amendments to their existing programs. It is good to see that this enthusiasm has continued all the year and that these children are still willing to spend part of a beautiful evening indoors on this work.

SCHOOL 12

This is a grammar school for girls of nearly six hundred pupils. Computer studies is one option of a sixth form general studies course, and is allocated one double lesson every six days. Because a six day timetable is in operation it is impossible for them to visit the computer centre on a regular basis, so they have the use of the on-line time-sharing terminal for their lessons. This time is completely devoted to programming. The programs that these girls have written are many and varied, ranging from pictures, maps, and games such as snakes and ladders to teaching programs of a question and answer type.

There is one member of staff concerned with this work who has been on a course at the computer centre and is following an Open University mathematics degree course which involves some computer science. There is in addition another member of staff who has been on a course at the computer centre and will take over this work next year.

COMMENT

This year there are eleven students in the group, three from the upper and eight from the lower sixth. As it happens they are all in the 'A' level mathematics group, so it was deliberately decided to make the programming non-mathematical. However, some work has been done on random number techniques and Monte Carlo methods which was new to them.

It is fortunate that working on a six day timetable, this school is able to use the terminal as often as it does. In fact this year there has only been one morning a week when the terminal is wanted elsewhere and when that day comes round for computer studies the girls have to forfeit its use. I hope that this will not be detrimental to the development of computer studies in this school in future years when the demand for the terminal will inevitably increase.

SCHOOL 13 The Royal Liberty School

This is a grammar school for boys of nearly six hundred pupils. It is fortunate in having the computer on the premises. This year six of the fifty-two boys taking 'A' level mathematics opted to do the alternative paper incorporating some computing. There is a copy of the syllabus in Appendix 1. They have eight lessons a week for their mathematics, out of which the computing must come. There is also a sixth form option for general studies allocated one hour and a half per week which was followed this year by ten students of all interests. Some work was done on computer appreciation, the use of computers in collecting and storing scientific information, statistical analysis and some data processing.

Each year in the autumn term the second year boys are given ten lessons of BASIC programming out of their mathematics time.

COMMENT

This school is in a very special position in relation to the computer studies as it is the school where all the work originated. The computer department is now completely separate from the school, and the school must book time to use it in the normal way.

Most of the work done using the computer is in the departments of economics and biology where, in the main, stored programs are used such as the economics business game for the 'A' level economics group. The computing done in the 'A' level mathematics course is minimal, being confined to simple numerical methods. From the numbers opting to follow this course it seems to be losing its popularity.

During the time I spent at the computer department the only boys from this school I saw using the computer were a small group of second years who came in every dinner time and after school when no-one else was there. They have worked entirely on their own to produce some magnificent programs. They use the computer and the on-line time-sharing terminal without supervision whenever they can and have achieved a great deal in this time.

A CRITICAL ASSESSMENT AND SUGGESTIONS

The first comment I should like to make is that the facilities at the computer centre are excellent. The computer will take punched tape, marked cards or typing directly on to the keyboard of a terminal, and the on-line time-sharing terminal to the Honeywell G 615 computer will take either punched tape or typing directly on to the keyboard. There is no restriction on the use of these, the pupils on the site come into the computer centre in the mid-day break and after school without supervision.

There is a punching service which schools can use if they wish. This prevents the wasting of time by students who have little typing ability, and speeds up the process of running a job and obtaining results. If, however, the school feels that a child should punch out tape for himself, six teletypes are available for their use at the computer centre and several schools have recently been given their own. Younger children especially enjoy marking their programs directly on to cards. This can be done in school, and many find it preferable to writing out coding sheets.

At the present site there is only room for about twelve children in the computer room at one time. However, there is a classroom very near with teletypes, an overhead projector, a blackboard and the usual classroom equipment of desks, tables and chairs. I suggest that more use could be made of this room. For example, school 10 has two classes doing computer studies, each of about thirty-six children. One week a third of one class go with their teacher to the computer centre to run programs, and the next week a third of the other class with their teacher. The remaining two thirds of the class each week is left in school with another teacher and left work to occupy them for the double lesson. One of the complaints these children had was the infrequency of their visits, and I suggest that an alternative arrangement would be for both teachers to go to the computer centre with one class the first week and the other class the next week. In this way the ones left at school would not be worse off, but the ones going to the computer centre would gain. One member of staff could supervise or teach the majority of the class

as he would in school while four or five at a time could go into the computer room to run their programs with the other member of staff. Each child would then be able to run a program every other week instead of once every six weeks as at present.

The situation could be further improved if there were one or more teachers or instructors permanently at the computer centre who could do this job instead of the teacher from the school. In this way schools would not be banned from offering the subject in a year when no member of staff was available with knowledge of computer studies.

It is gratifying to see that the majority of schools are making the effort to include this relatively new subject in their curricula. It is inevitable that if time is required for a new subject it must be taken from that allotted to existing work. I should like to see computer studies less as a pioneering effort on the part of a few enthusiasts and more as an accepted fact in our lives.

One suggestion I should like to make is for a borough policy with some incentive to come from the office, via the adviser, for every secondary school to have computer studies on the timetable in at least one of the first three years. I would suggest that a one year course should be done in the third year, a two year course in the second and third years or a three year course in the first three years, possibly building up towards the latter. The subject should be allotted a definite minimum proportion of time in all schools and time automatically booked for the school to visit the computer centre or have the use of the terminal. I would suggest three or four lessons a week including one double for a visit to the computer centre or other local installations. The one or two remaining lessons should be used for a course on computer appreciation with some programming, but the programming not to play the major role. Visits or outside speakers could occasionally be included in the double period. Any school who wanted to run a CSE or 'A' level course in computing would then be sure that all pupils were starting with a firm background on which to build new work, and those children who eventually decide to take up a career in computing will know exactly what they are choosing and that their choice

is the correct one.

One person per school should be appointed specifically to teach this subject together with his or her own subject. This teacher may have any background, not necessarily mathematical or scientific although some elementary mathematical knowledge is needed, for example 'O' level. No previous knowledge would be required on appointment but rather a willingness to attend courses both in his own and school time. In particular it would be advisable to start this scheme with newly appointed teachers to a school wherever possible, to break away from the present trend that the head of mathematics should necessarily be responsible. This will discourage the arts specialists leaving college from thinking that the subject is foreign to their aptitude.

It is interesting to see that the children in school 6 are taught programming as they would be taught a language. They read the BASIC statements, copy and run the program and gradually come to realise what result a particular line will have. This approach seems to have been very successful and may well be adopted by arts specialists in preference to the more usual teaching methods.

I think it would be helpful if the staff concerned were appointed by people interested in the subject, for instance the adviser for computer studies or the head of the computer centre. I should like to see a team of people in charge of this work, headed by a computer studies adviser. These people would then be responsible for the work done at the computer centre, and the organisation of meetings of interested people who could discuss the work they think should be done and make suggestions which would then be assembled by the experts into a suitable syllabus giving the important topics a definite place, with options so that individual teachers may choose according to their own interests.

They would also be expected to visit schools, and see lessons so that they can note what help is required and offer suggestions where appropriate, especially to young people starting in the profession. I feel that they should have some sort of authority to encourage head teachers to support the work being done in their schools and to expand the scope of work in the borough. I know this can be done as I have seen

a similar system in operation in connection with other subjects, notably physical education.

I feel that at the moment the teachers tackling this subject have very little knowledge themselves of what a computer is, what it does and how it works. They are making every effort to go on courses and find out about programming and many think that this is an end in itself. I disagree. To my mind programming is a small part of computer studies, especially the mathematical type mainly done. I was disappointed to hear that most of the people to whom I spoke on my visits to the schools had made little effort to find out more about the subject apart from attending some of the programming courses held at the computer centre. This may be due to lack of time or the inability to know where suitable information can be found. I should be surprised to be told that it was due to lack of interest as I was very impressed on the whole with the enthusiasm shown by these people. I have wondered on several occasions if programming is taught in most schools because there is a computer available, or if the computer is there because programming is taught. I have come to the conclusion that for most people the former is true, and wonder if having such excellent facilities for programming detracts from the other work which might be done.

There seem to me to be two main types of teachers. Firstly, ones who are established in their profession, who have chosen their subject interests and have a stable position within the school. Usually these people have long standing spare time commitments or family ties. The other type is comprised of the young people recently out of college and older people who feel that their capacities are not fully used. At present these are the ones who are doing part time degree or similar courses at the local technical college or the Open University, who may well benefit themselves, the borough, the children and other teachers by being given worthwhile mind-stretching work to do. Too often these are the ones who leave teaching for some other sort of work in education to the detriment of the teaching profession. This is inevitable in the present situation but I should like to suggest how it may be altered.

Imagine a young teacher of this type coming into a borough

where there was a thriving group of teachers who met once a week after school to discuss a subject such as computing, how it could be taught, different approaches used, different topics included and perhaps groups doing some research into CAI as applied to their particular subject interests. After one or two visits, the young teacher is likely to have been fired with sufficient enthusiasm to join the group and contribute to the work. At the present time most of the research in computer education is being done in the universities whereas people in the teaching profession feel that teachers should be able to make some contribution, which this organisation would enable them to do. Once a group such as this was started, there should be no difficulty in continuing the work, but a great deal of enthusiasm would be needed to set up this situation.

Although these ideas are idealistic at this point in time, this may become feasible in the future when the subject is better established. In any case I suggest that teachers should meet each term to discuss developments both local and national, to amend syllabuses, to arrange exhibitions of work, competitions and the opportunity for children from different schools to meet each other much on the same lines as a chess club or a debating society. This would make the subject more lively than the usual classroom lessons.

In conclusion, the weeks I have spent in obtaining the material for this work have been varied and interesting. Previously, although I had heard of the marvellous reputation of the London Borough of Havering I had no detailed knowledge of the work being done there. I feel that this work is entirely due to the efforts and enthusiasm of Mr. Broderick, who has given much time and energy to making this scheme the success it is. I hope that I have given a sufficiently accurate overall picture as I see it of this most worthwhile work.

APPENDIX 1

EXAMINATION SYLLABUSES

EAST ANGLIAN EXAMINATIONS BOARD

for the

CERTIFICATE OF SECONDARY EDUCATION

DURY FALLS SCHOOL - MODE 3

COMPUTER STUDIES PAPER 1

$1\frac{1}{2}$ hours

Answer SIX Questions only.

1) a) Calculate the following:-

i) 1101 + 11011
ii) 10101 x 11101
iii) 111111 ÷ 111

b) Operating instructions state 'enter at 596' What would be the set-up on the control keys of a 903 or 905 computer? (1 = key depressed, ∅ = key up).

2) a) Explain the term Switch Statement and briefly outline its use in some programs.

b) Show the different forms of loop statement which can be made in programs.

3) "The digital computer can only add". If this is true, show how the computer carries out the following arithmetic functions:-

a) Multiplication using 8 x 7 as an example.
b) Subtraction using 76 - 5 as an example.
c) Division using 75 ÷ 5 as an example
(You may assume the subtraction process)

4) Using Hero's method, calculate sqrt (13) to two decimal places. Show each step of your working clearly. Compare your result with that obtained in four figure tables.
Express the difference between your result and that of the table result as a % error.

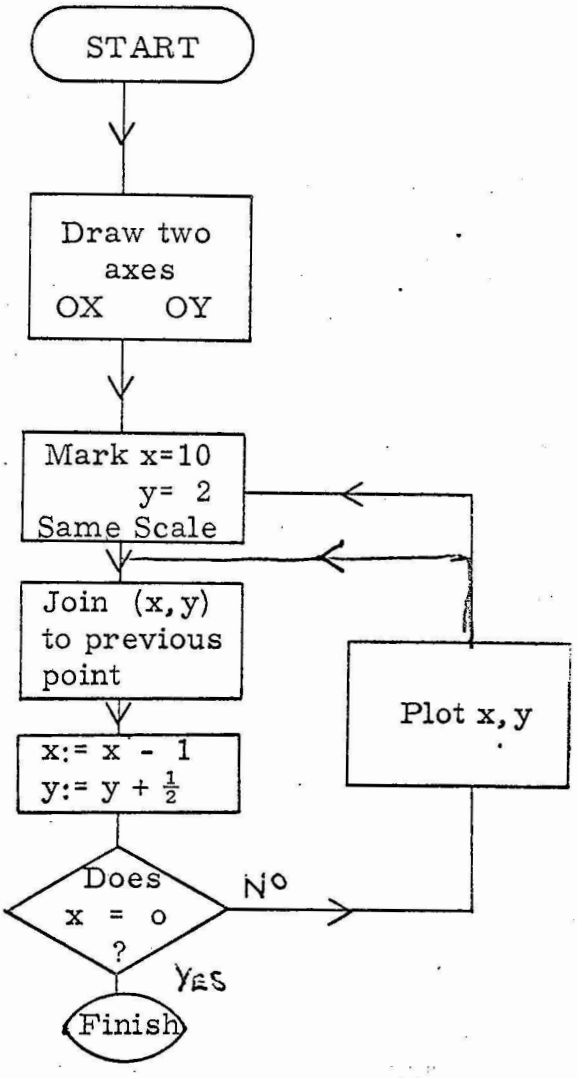
5) a) Write in Algol notation:-

i) $3ab^2$
ii) $\frac{5(a + b)}{3(a - b)}$
iii) $\sqrt{5\sqrt{a + b^2}}$

b) Express as ordinary algebraic statements:-

i) 3 * A + B
ii) - B * A/C + SQRT (D))
iii) 3 * (A + B) + 5 * (A - B) ↑3

6)



Using graph paper, follow the instructions in the flow diagram and plot the graph.

What is the equation of the line?

7) Write short notes on three of the following:-

i) Peripheral equipment
ii) On line working
iii) Backing store
iv) Computer Graphics.

8) What would be output from the following Algol statements?

Given that A: = 3.3;
X: = 7;
L: = 5.3.

a) "PRINT" A, A/3
b) "PRINT" X, SAMELINE, //S5\\ X↑3
c) "PRINT" /£\ SAMELINE, L, //S4\ $\
ALIGNED (2,2), L * 2.39

EAST ANGLIAN EXAMINATIONS BOARD S/8/8N/CS

for the

CERTIFICATE OF SECONDARY EDUCATION

DURY FALLS SCHOOL - Mode 3

COMPUTER STUDIES PAPER 11

$1\frac{1}{2}$ hours

Attempt THREE questions.

1) By using switch statements, write an ALGOL Program to evaluate the formula

$$X = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

for the following values of a, b, c

a) 7, -8.5; b) 3.5; 9; c) -5.78, 3.5

Answers to be expressed with no more than TWO places of decimals.

2) Write a SIR program to input a set of integers, total them and output the total. Stop when zero is input.

3) Either a) Write a brief account of the use of computers in money handling banking credit cards etc.

OR b) A farmer wishes to buy some more cows and sheep and goes to market. Cows need 2 acres and sheep 1 acre of pasture each but he has only another 40 acres available. Cows cost £10 each but only the best Southdown sheep are available at £20 each. The farmer has only £500 to spend. The farm expects to make £10 profit from the milk of a cow in a year and £10 from the fleece of a sheep.

By a graphical method find:

(i) How many of each animal he should buy to secure a maximum annual profit.

(ii) What this profit is.

CERTIFICATE OF SECONDARY EDUCATION

Computer Studies - Mode 3.

School submitting syllabus - Dury Falls School
Wingletye Lane,
HORNCHURCH, Essex.

The examination is intended to follow a Two Year Course of Study the Scheme of which is appended, and is planned around a time-table allocation of one double period (approx. 1½ hrs.) and about five hours attendance at the Computer Centre in Havering, during the term.

Visits to installations should be arranged as available for about one per term.

Practical work should be submitted for assessment about once per month.

The Examination shall consist of the following:

Paper One - Ten short questions covering a wide range of the syllabus, of which the answers to eight are expected. 30% marks

Paper Two - Longer questions :
1) A program in Basic.
2) A problem in Linear Programming.
3) A short essay on a specified topic. 30% marks

Work book Assessment - the cumulative total of marks obtained for work during the course - together with a general overall review. 20% marks

Project - The requirements of the project are mentioned in the Scheme appended. 20% marks.

It is intended to submit candidates for this examinatinn in the 1973 series.

Scheme of Study.

1. Brief outline of the history of mechanical methods of computing.

2. Representing numbers by electrical pulses - Binary Arithmetic.

3. The desk calculator - Operations compared with that of the computer.

4. Writing instructions for thedesk calculator - simple programs.

5. Flow charts - as a topological representation of the problem to be solved.

6. The computer as a sophisticated calculator. Block schematic. Simple ideas of logic circuits.

7. Analogue and digital computers compared.

8. Programming a digital computer. Assembler Language.

9. High level languages - Basic. Other languages - ALGOL, FORTRAN COBOL.

10. Basic Programming - Programming in Basic for the H.P computer and for the Time Sharing Service available.

11. Input and output methods - Tape cards (punch and marked) Conversational modes of input and output.

12 Storage devices - backing stores - Tape and Disc.

13 Commercial procedures - Studied through visits to computer installations.

14. Some discussion on the problems of data processing - Linear Programming.

15. General study of the wide range of computer applications. Medical, commercial, industrial and scientific. Computer Graphics.

16. Social implications and Security of computer based files and records.

17. The Computer Industry and its organisation.

Practical Work - The writing and correcting of programs in Basic. Ideally the pupil should run about 15 or 20 programs of a practical nature to illustrate the following:

- Simple four rules.
- Exponentiation.
- Conversion Lists.
- Graphs and Flow charts.
- Commercial Programs - HP, accounting etc.

Such work will be recorded in a Work Book and will record the original program; errors which may have occurred and their correction. Notes on opprating the systems encountered.

Project - The project shall be on a topic of the pupil's chosing and shall be assessed on the following points: Originality, clarity, illustrations and general neatness. Itsis not intended to lay down a rigid length (no. of pages) but a reasonable evidence of reading and research is expected from the content of the submitted work.

Use of visual aids and visits to computer installations is anticipated to supplement the more formal classroom instruction.

A1.6

APPENDIX 3

The syllabus below is not the standard London University G.C.E. 'A' Level Pure Mathematics syllabus, but one that the Board has specially approved for use in The Royal Liberty School. This syllabus and the examination question papers that follow have been reproduced by kind permission of the University of London School Examinations Department.

THE ROYAL LIBERTY SCHOOL, ROMFORD

PARALLEL ADVANCED LEVEL SYLLABUS IN PURE MATHEMATICS

Preamble

The following syllabus is an adaptation of the London University Advanced Level Pure Mathematics Syllabus. It is intended to make the same intellectual demands on students as the above mentioned syllabus whilst providing a workable alternative changing the emphasis to elementary numerical analysis and the solution of problems on an electronic digital computer.

Note: To aid comparison changes are shown in italics.

PAPER I

PROPERTIES OF POLYNOMIALS OF DEGREE LESS THAN OR EQUAL TO FIVE, INCLUDING THE RELATIONSHIPS BETWEEN ROOTS AND COEFFICIENTS.

Simple algebraic functions. The theory of indices and logarithms. The Binomial Theorem for a positive index. The use of the expansion $(1+X)^n$, where n is fractional or negative, simple approximations, Determination of a linear law from experimental data.

Rectangular Cartesian coordinates, including parameters, applied to the straight line, circle and parabola. Easy problems on loci.

Circular measure. Small angles, including the use of limits such as $\sin\theta/\theta$ as θ tends to zero.

Trigonometric functions of compound angles. The differentiation of simple algebraic, trigonometric (excluding inverse functions), exponential and logarithmic functions. Differentiation of a sum, product, quotient and simple cases of a function of a function and of implicit functions. Application to gradients, maxima and minima.

Definite and indefinite integration of simple functions. APPLICATIONS TO AREA AND VOLUME.

SIMPLE MATRIX ALGEBRA—ADDITION, SUBTRACTION & MULTIPLICATION OF MATRICES.

LINEAR TRANSFORMATION: THE PROPERTIES OF DETERMINANTS OF MATRICES INCLUDING LINEAR DEPENDENCE.

Elementary Boolean Algebra including the operators 'and' & 'or'.

PAPER II

The convergence of geometric series. SUMMATION OF SIMPLE FINITE ALGEBRAIC SERIES: THE EXPONENTIAL AND LOGARITHMIC SERIES.

Identities, including Partial Fractions, the remainder theorem, simple inequalities.

General solutions of trigonometrical equations (including a cos x + b sin x=c). Differentiation of $\sin^{-1}x$ and $\tan^{-1}x$. SIMPLE EXAMPLES OF INTEGRATION BY SUBSTITUTION AND INTEGRATION BY PARTS.

Applications of the calculus to rates of change, AND CENTROIDS.

Solution of Equations—graphical methods, NEWTON RAPHSON.

SOLUTION OF SIMULTANEOUS EQUATION USING DETERMINANTS AND MATRICES.

INTEGRATION—SIMPSONS RULE, TRAPEZIUM RULE AND SIMULATION METHOD.

Hyperbolic functions—INTEGRATION, differentiation and GENERAL PROPERTIES.

SIMPLE FIRST ORDER DIFFERENTIAL EQUATIONS.

USE OF TAYLOR & MACLAURINS THEOREM FOR THE EXPANSION OF A FUNCTION.

NEWTON'S METHOD OF SUCCESSIVE APPROXIMATIONS.

Practical

Students will be expected to have studied methods of programming the topics in Block Capitals with a view to obtaining solutions on a computer where floating point arithmetic is carried out to an accuracy of at least six significant figures on the decimal scale and to carry out simple error analysis on this basis.

The use of one of the approved languages is permitted for description purposes in questions and answers in paper I and II.

Practical Books

The student may be required to produce a practical note book for inspection by the Examiners. There will be no other form of practical examination.

A1.7

Mathematics

(*Subject numbers are shown below*)

Advanced Level

The subjects that may be offered are:

Pure Mathematics (*Subject number* **380**)

Applied Mathematics (*Subject number* **390**)

Mathematics (Pure and Applied) (*Subject number* **400**)

Higher Mathematics (*Subject number* **410**). *Higher Mathematics may be taken at the Summer examination only.*

380 Pure Mathematics

Advanced Level

This subject may not be taken by candidates taking either Mathematics at the Ordinary level or Mathematics (Pure and Applied) at the Advanced level.

Candidates who offer Pure Mathematics and Applied Mathematics and who fail in both subjects may be awarded a pass in Mathematics (Pure and Applied) if they satisfy the examiners in Paper 1 of each subject. Candidates who pass in only one subject may be given an alternative pass in Mathematics (Pure and Applied) if they satisfy the examiners in Paper 1 of each subject. Candidates who pass in both subjects will be given an alternative result in Mathematics (Pure and Applied) based on their performance in Paper 1 of each subject.

Questions will be set in the S.I. system of units.

Four-figure mathematical tables* will be provided by the University. The use of slide rules will also be permitted.

There will be three papers, each of 3 hours. Candidates must take Paper 1 and one other paper. It is desirable that candidates for Paper 3 should have had access to a computer. Candidates taking this paper must have followed a course of practical work, and may be required to produce a practical notebook for inspection by the examiners.

Paper 1

The theory of the quadratic function and of quadratic equations. Simple algebraic functions. The theory of indices and logarithms.

Complex numbers: sum, product and quotient of complex numbers in algebraic form, Argand diagram.

Permutations and combinations. Elementary examples in the use of induction. The binomial theorem for a positive integral index. The use of the expansion $(1 + x)^n$, where n is fractional or negative; simple approximations. Determination of a linear law from experimental data.

Rectangular cartesian coordinates, including parameters, applied to the straight line, circle and parabola. Easy problems on loci.

Circular measure; small angles, including the use of limits such as $\sin\theta/\theta$ as θ tends to zero. The formulae for $\sin(A \pm B)$ and $\cos(A \pm B)$. Periodic properties

* Four-figure Tables by Godfrey and Siddons, C.U.P. See footnote, p. 122.

of trigonometric functions. Sine and cosine formulae for a triangle with elementary applications. General solution of equations such as $\cos\theta = \cos\alpha$. Expression of $a\cos\theta + b\sin\theta$ in the form $r\cos(\theta - \alpha)$. De Moivre's theorem for a positive integral index.

The differentiation of simple algebraic, trigonometric (excluding inverse functions), exponential and logarithmic functions. Differentiation of a sum, product, quotient and simple cases of a function of a function and of implicit functions.

Applications to gradients, maxima and minima. Simple curve tracing.

Definite and indefinite integration of simple functions. Applications to area and volume.

Paper 2

The convergence of geometric series. Summation of simple finite algebraic series.

The relations between the roots of an algebraic equation and its coefficients.

The exponential and logarithmic series.

Identities, including partial fractions; the remainder theorem.

Handling of simple inequalities.

Further applications of de Moivre's theorem: the cube roots of ± 1.

Rectangular cartesian coordinates, including parameters, applied to the ellipse and hyperbola.

The determination of the angles made by planes and straight lines with one another. The mensuration and simpler properties of common solids including the tetrahedron, cone and sphere; any appropriate methods may be used. Cartesian coordinates in three dimensions; direction cosines, equations of a plane and of a straight line.

Differentiation of arc $\sin x$ and arc $\tan x$. Simple examples of integration by substitution and integration by parts. Applications of the calculus to rates of change, tangents and normals and centroids.

Further sketching of graphs including those of algebraic functions such as $(ax^2 + bx + c)/(px^2 + qx + r)$ and of simple transcendental functions.

Paper 3

The mathematical content of the work is indicated in the paragraphs below. Candidates will be expected to be able to write, where relevant, computer programs in a suitable language (e.g., Algol, Fortran etc.) for the solution of problems involving a knowledge of these topics.

Flow diagrams. The convergence of geometric series. Summation of simple finite algebraic series. The use of Taylor's series and Maclaurin's series for the expansion of a function; the exponential, logarithmic and trigonometric series. Simple properties of the hyperbolic functions.

Differentiation of inverse functions. Simple examples of integration by substitution, by partial fractions and by parts. Integration of first-order differential equations in which the variables are separable. Numerical solution of first-order differential equations by step-by-step methods, including the modified Euler method. Numerical integration by the trapezium rule, the mid-ordinate rule and by Simpson's rule.

Addition, subtraction and multiplication of matrices; the determinant, inverse and characteristic equation of a 3×3 matrix. The application of matrices to linear transformations and to the solution of a system of linear equations. The solution of a system of simultaneous linear equations by Gaussian elimination and by the Gauss-Seidel method. Residuals.

The relations between the roots of an algebraic equation and its coefficients. Solution of non-linear equations by graphical and iterative methods, including the Newton-Raphson method. Linear and quadratic convergence.

Elementary Boolean algebra, including 'and', 'or', 'not', 'nand' and 'nor' connectives.

A Special paper will be set in this subject; see Regulation III (page 4).

390 Applied Mathematics

Advanced Level

This subject may not be taken by candidates taking Mathematics (Pure and Applied) at the Advanced level

Candidates who offer Pure Mathematics and Applied Mathematics and who fail in both subjects may be awarded a pass in Mathematics (Pure and Applied) if they satisfy the examiners in Paper 1 of each subject. Candidates who pass in only one subject may be given an alternative pass in Mathematics (Pure and Applied) if they satisfy the examiners in Paper 1 of each subject. Candidates who pass in both subjects will be given an alternative result in Mathematics (Pure and Applied) based on their performance in Paper 1 of each subject.

Questions will be set in the S.I. system of units.

Four-figure mathematical tables* will be provided by the University. The use of slide rules will also be permitted.

There will be two papers, each of 3 hours.

Paper 1

The addition and subtraction of vectors. Moments and couples. Equilibrium of a particle and of a rigid body under the action of a system of coplanar forces. Centre of mass. Friction. Hooke's law.

Kinematics of a particle (a) moving in a straight line with acceleration a function of the time or a function of the distance (but excluding the determination of the position of the particle from the given data) (b) moving with simple harmonic motion (c) moving in a circle with uniform speed.

Concept of relative velocity.

Newton's laws of motion, mass, momentum, force, impulse, work, energy and power. The principles of conservation of energy and momentum.

Direct impact of perfectly elastic spheres and extension to the case of imperfectly elastic spheres.

Elementary treatment of projectiles.

Paper 2

(Candidates are expected to be familiar with the notion that such diverse physical quantities as displacement, velocity, acceleration and force can be represented by directed line segments (vectors) obeying the same law of addition.)

Vectors; addition, subtraction and multiplication by a scalar. Direction of a vector, direction cosines, components of a vector, magnitude of a vector, unit vector. Position vector, position vector of a point dividing two points in a given ratio. Vector equation of a straight line, equivalent cartesian forms in two and three dimensions. Position vector in terms of a parameter, parametric representation of a simple curve, such as the circle $\mathbf{r} = a\cos p\,\mathbf{i} + a\sin p\,\mathbf{j}$ and the parabola $\mathbf{r} = ap^2\mathbf{i} + 2ap\,\mathbf{j}$. Scalar product of two vectors.

* Four-figure Tables by Godfrey and Siddons, C.U.P. See footnote, p. 122.

APPENDIX 2

PROGRAMS WRITTEN BY CHILDREN

SCHOOL 7 YEAR 4

```
            psf 367
rainfall wheeler;
"begin""integer"n,j,k;
        "read"n;
        "print"'''t2s2cmonthly rainfall6;
        "for"j:=1"step"1"until"12"do"
        "begin""print"''t6c;
        "read"n;
        n:=n;
        "for"k:=1"step"1"until"n"do"
        "print"'x6
        "end"
"end";
1.6,2.3,4.7,6.9,7.1,10.2,1.5,5.3,2.7,4.6,3.9,8.9;
```

```
    psf322
squares white;
"begin""integer"n,s;
        "print"''t1s1cnumber's3csqrs6;
        "for"n:=-10"step"2"until"12"do"
        "begin"s:=n↑2;
                "print"n,sameline,s
        "end"
"end";
```

```
        psf 348
rainfall evans;
"begin""integer"n,j,k;
        "real"n;
        "print"''t2s2cmonthly rainfall6;
        "for"j:=1"step"1"until"12"do"
        "begin""print"''t6c;
        "read"n;
        n:=n;
        "for"k:=1"step"1"until"n"do"
        "print"'x6
        "end"
"end";
1.3,14.3,13.5,17.3,12.9,9.9,8.6,3.4,6.7,12.8,1.3,26.1;
```

SCHOOL 7 YEAR 4

```
      psf 152
volume of cylinders wheeler;
"begin""integer"k,r,h;
        "real"p,v;
        p:=3.141593;
        "for"k:=1"step"1"until"4"do"
        "begin""read"r,h;
              v:=p*r*r*h;
              "print"´´ł3ł0,r,´=radius0,
                              h,´=height0,
                              v,´=volume0
        "end"
"end";
24,5;5,10;6,12;14,10;
```

```
psf125
area of rectangle buttifant;
"begin""integer"k;
          "real"a,l,b;
          "for"k:=1"step"1"until"6"do"
            "begin""read"l,b;
                    a:=l*b;
              "print"a,´is the area0
            "end"
"end";
17.1,8.4;2.7,9.4;7.8,27.3;47.3,2.8;8.07,9.1;3.3,1.1;
```

```
psf125
volume evans;
"begin""integer"k;
          "real"vol,l,b,h;
          "print"´´ł2s7volume of a cuboid0,
                 ´´ł2s2:length´s9:breadth´s8:height´s8:volume0;
            "for"k:=1"step"1"until"4"do"
          "begin""read"l,b,h;
                  vol:=l*b*h;
                "print"l,´´s3ł0,sameline,b,´´s3ł0,h,´´s3ł0,vol
            "end"
"end";
1.2,1.2,1.2;  0.5,3.2,0.61;  6.6,6.6,6.7;  2.1,3.4,0.2;
```

SCHOOL 6 YEAR 2

```
5   PRINT " GRAPH OF X↑2-5X+6"
10  FOR X=0 TO 5 STEP .5
20  LET Y=X↑2-5*X+6
30  LET Y1=(Y+1)*5/7
40  FOR K=1 TO 58
50  IF K=INT(Y1) THEN 80
60  PRINT " ";
70  GOTO 90
80  PRINT "*";
90  NEXT K
100 PRINT K
110 NEXT X
120 END
```

```
READY
RUN
 GRAPH OF X↑2-5X+6
                                                        * 0
                                                  *       .5
                                                *         1
                                            *             1.5
                                          *               2
                                        *                 2.5
                                          *               3
                                            *             3.5
                                              *           4
                                                  *       4.5
                                                    *     5

READY
```

```
10  PRINT "SOLVE OUT MATRIX 2"
20  DIM A[2,2],B[2,2]
30  MAT  READ A
40  MAT B=INV(A)
50  MAT  PRINT A,B
60  DATA 3,7,2,5
70  END

READY
RUN
 SOLVE OUT MATRIX 2
 3             7

 2             5

 .714286       -.999999

-.285714       .428571

READY
```

SCHOOL 9 YEAR 3

```
 10    REM G. INGLE
 20    REM AREA OF TRIANGLES
 30    PRINT SPC (12);"AREA OF TRIANGLES"
 40    PRINT SPC (3);"BASE"; SPACE (9);"HEIGHT";
 50    FOR J=1 TO 5
 60    READ B,H
 70    DATA 2,4,3,6,4,8,5,10,6,12
 80    LET A=B*H/2
 90    PRINT B,H,A
100    NEXT J
110    END
RUN
```

```
 10 REM M ROWLAND
 20 REM SPC(14);"AREA OF RECTANGLES"
 30 PRINT SPC(6);"LENGTH"SPC(10);"BREADTH"SPC(11);"AREA"
 40 FOR X=1 TO 6
 50 READ L,B
 60 DATA 1,2,2,4,4,6,6,8,8,10,20,22
 70 LET A=L*B
 80 PRINT L,B,A
 90 NEXT X
100 END
RUN
```

SCHOOL 6 YEAR 2

```
10    PRINT "1,2,3,4,"
20    FOR N=1 TO 10
30    READ K,L
40    DATA 1,2,3,4,5,6,7,8,9,10
50    DATA 25,7,11,13,15,17,19,20,22
60    PRINT K,L,K+L,K*L
70    NEXT K
80    END
```

```
1,2,3,4,
```

2	3	2
4	7	12
6	11	30
8	15	56
10	19	90
7	32	175
13	24	143
17	32	255
44	39	380

```
OUT OF DATA IN 30
```

SCHOOL 5 YEAR 2

```
SCRATCH
010    REM JEAN CASSIDY
020    PRINT "TO FIND THE VERTICAL ANGLE OF ISOSCELES TRIANGLE"
030    PRINT"ANGLE A IS VERTICAL ANGLE"
040    PRINT"ANGLES B AND C ARE BASE ANGLES"
050    READ B,C
060    LET A=180-(B+C)
070    DATA 78,78
080    PRINT "THE ANSWER IS";A
090    END
LIST
RUN
```

```
NEW
010 REM FOOTBALL HISTOGRAM
020 PRINT " WESTHAM 1 EVERTON 2 SPURS 3 "
030 PRINT " MAN UTD 4 LIVERPOOL 5 ARSENAL 6 "
040 PRINT "                          TEAM "
050 FOR J = 1 TO 6
060 READ K
070 LET N=K-1
080 PRINT J,
090 IF N>=1 THEN 130
100 IF N<1 THEN 110
110 PRINT "0"
120 GO TO 170
130 FOR K= 1 TO N
140 PRINT "X";
150 NEXT K
160 PRINT "X"
170 NEXT J
180 DATA 15 ,0,5,2,0,5
190 END
RUN
```

SCHOOL 12 YEAR 6

```
:34 IEM R33.337  SLOS
*LIST

10 LET D=0
15 INPUT A
20 FOR J=1TO
30 LET A=VAL(-D)
40 LET A=VAL(-D)
50 LET G=(A+2)*(A+2)
60 IF J=<1 THEN 90
70 LET D=0
80 GOTO 110
90 LET D=D+1
100 NEXT J
110 PRINT "FIRST 5 OF PI IS "3.1415
999 END

:SOLO

>
```

SCHOOL 11 YEAR 1

```
 10  LET R=6370
20  LET P=3.14159
30  PRINT "THE EARTH"
35  PRINT
40  PRINT "RADIUS";TAB(38);R;"KM"
50  PRINT "CIRCUMFERENCE";TAB(38);2*P*R
70  PRINT "VOLUME";TAB(38);4/3*P*R↑3;"KM↑3"
80  PRINT TAB(38)"=";4/3*P*(1000*R)↑3;"M↑3"
90  PRINT "MASS";TAB(38);4/3*P*((1000*R)↑3)*5.5*10↑3;"KGM↑3"
100  END
```

```
1370 PRINT" EARTH    =  7.0 MPS
  ERROR 20   IN LINE  1370
1450 PRINT" PLUTO    =  ?
  ERROR 20   IN LINE  1450
  10 PRINT"         ****ASTRONOMY*****"
  20 PRINT
  30 PRINT"INPUT:1 FOR STAR TYPES"
  40 PRINT"       2 FOR PARALLAX MEASUREMENTS"
  50 PRINT"       3 FOR LIGHT-DISTANCES"
  60 PRINT"       4 FOR CEPHEID-VARIABLES"
  70 PRINT"       5 FOR STELLAR-CLUSTERS"
  80 PRINT"       6 FOR COMETS"
  90 PRINT"       7 FOR ESCAPE VELOCITIES"
 100 INPUT A
 110 IF A=1 THEN 190
 120 IF A=2 THEN 800
 130 IF A=3 THEN 860
 140 IF A=4 THEN 1120
 150 IF A=5 THEN 1220
 160 IF A=6 THEN 1270
 170 IF A=7 THEN 1360
 180 GOTO 30
 190 PRINT"    ***STAR TYPES***"
 200 PRINT
 210 PRINT"FOR:W+O TYPE STARS INPUT 2"
 220 PRINT"       B TYPE STARS INPUT 2"
 230 PRINT"       A TYPE STARS INPUT 3"
 240 PRINT"       F TYPE STARS INPUT 4"
 250 PRINT"       G TYPE STARS INPUT 5"
 260 PRINT"       K TYPE STARS INPUT 6"
 270 PRINT"       M TYPE STARS INPUT 7"
 280 PRINT"       N TYPE STARS INPUT 8"
 290 PRINT"       R TYPE STARS INPUT 9"
 300 PRINT"       S TYPE STARS INPUT 10"
 310 INPUT B
 320 IF B=1 THEN 430
 330 IF B=2 THEN 470
 340 IF B=3 THEN 510
 350 IF B=4 THEN 550
 360 IF B=5 THEN 590
 370 IF B=6 THEN 630
 380 IF B=7 THEN 670
 390 IF B=8 THEN 710
 400 IF B=9 THEN 740
 410 IF B=10 THEN 770
 420 GOTO 21
 430 PRINT"W+O-WOLF-RAYET STARS:VERY HOT,GREENISH OR BLUISH-WHITE."
 440 PRINT"MEAN TEMPERATURE:35,000 K(W STARS MAY REACH 50,000DEG.C)"
 450 WAIT(6000)
 460 GOTO 30
 470 PRINT"B-ORION OR HELIUM STARS:VERY HOT,MASSIVE STARS(E.G.RIGEL)"
 480 PRINT"MEAN TEMPERATURE:25,000 K"
 490 WAIT(6000)
 500 GOTO 30
 510 PRINT"A-SIRIAN OR HYDROGEN STARS:HOT WHITE STARS (E.G.SIRIUS)"
 520 PRINT"MEAN TEMPERATURE=11000 K"
 530 WAIT(6000)
 540 GOTO 30
 550 PRINT"F-CALCIUM STARS:YELLOWISH-WHITE(E.G.CANOPUS)"
 560 PRINT"MEAN TEMPERATURE=7500 K"




 570 WAIT(6000)
```

```
570 WAIT(6000)
580 GOTO 30
590 PRINT"G-SOLAR STARS(GIANT+DWARF STARS)OF YELLOW COLOUR(E,G,SOL)"
600 PRINT"MEAN TEMPERATURE=6000 K"
610 WAIT(6000)
620 GOTO 30
630 PRINT"K-ARCTURIAN STARS:GIANT ORANGE-YELLOW STARS(E,G,ARCTURUS)"
640 PRINT"MEAN TEMPERATURE=4500 K"
650 WAIT(6000)
660 GOTO 30
670 PRINT"M-ANTARIAN STARS:GIANT OF DWARF ORANGE STARS(E,G,ANTARES)"
680 PRINT"MEAN TEMPERATURE:3500 K"
690 WAIT(6000)
700 GOTO 30
710 PRINT"N-CARBON STARS:DEEP ORANGE-RED STARS(E,G,       )"
720 PRINT"MEAN TEMPERATURE:2600 K"
730 GOTO 30
740 PRINT"R-(LIKE N-STARS:ORANGE-RED STARS(LESS RED THAN N)"
750 PRINT"MEAN TEMPERATURE:2300 K"
760 GOTO 30
770 PRINT"S-RED STARS,LONG PERIOD VARIABLES"
780 PRINT"MEAN TEMPERATURE:2000 K"
790 GOTO 30
800 PRINT" ***PARALLAX MEASUREMENTS***"
810 PRINT
820 PRINT"TO MEASURE STAR DISTANCES PARALLAX CAN BE USED,IT USES TRI-"
830 PRINT"GONOMETRY, BUT BECOMES UNUSABLE FOR DISTANCES OVER 100 "
840 PRINT"PARSECS."
850 GOTO 30
860 PRINT" **LIGHT DISTANCES"
870 PRINT
880 PRINT"LIGHT SECOND=186000 MILES"
890 PRINT"LIGHT MINUTE=11160000 MILES"
900 PRINT"LIGHT HOUR  =669600000 MILES"
910 PRINT"LIGHT DAY   =1607000000 MILES"
920 PRINT"LIGHT WEEK  =112492.88 MILLION MILES"
930 PRINT"LIGHT MONTH =449971.2 MILLION MILES"
940 PRINT"LIGHT YEAR  =5880000  MILLION MILES"
950 PRINT"  PARSEC    =19150000 MILLION MILES"
960 PRINT"LIGHT CENTURY=588000000000000 OR 588*10↑12 MILES"
970 PRINT"LIGHT MILLENNIA=5880000000000000 OR 588*10↑13"
980 PRINT
990 PRINT"INPUT 1 TO RESTART OR 2 TO GO TO THE DOPPLER EFFECT";
1000 INPUT B
1010 IF B=1 THEN 30
1020 PRINT" ***THE DOPPLER EFFECT AND LIGHT SHIFT***"
1030 PRINT
1040 PRINT"IF AN OBJECT IS TRAVELLING TOWARD ANOTHER OBJECT,ITS LIGHT"
1050 PRINT"OR SOUND WILL APPEAR TO BE HIGHER AS THE WAVES WILL CRAM"
1060 PRINT"THEMSELVES AGAINST THE RECEIVER(IN THE CASE OF LIGHT BLUER)"
1070 PRINT"IN THE CASE OF A RECEDING OBJECT A LOWER NOTE OR "
1080 PRINT"REDDER COLOUR"
1090 PRINT"ALL GALAXIES SHOW THAT THEY ARE TRAVELLING AWAY FROM US BY"
1100 PRINT"THE APPARENT SHIFT INTO THE RED PART OF THE SHIFT"
1110 GOTO 30
1120 PRINT" CEPHEID-VARIABLES"
1130 PRINT
1140 PRINT"VARIATIONS OF THESE STARS ARE ALWAYS ABSOLUTELY REGULAR"
1150 PRINT"THE PERIOD OF A VARIABLE IS LINKED DIRECTLY WITH ITS LUMIN-"
1160 PRINT"OSITY,SO THE DISTANCE MAY BE DEDUCED. THESE STARS ARE FOU-"
```

iii

```
1170 PRINT"ND IN OTHER GALAXIES,SO IT IS ANOTHER METHOD OF GAUGING THE"
1180 PRINT"DISTANCE.THESE STARS ARE NAMED AFTER THE FIRST FOUND CEPHEI"
1190 PRINT"=D, DELTA CEPHEI WHICH HAS A PERIOD OF 5.71 DAYS"
1200 PRINT
1210 GOTO 30
1220 PRINT" STELLAR CLUSTER (GLOBULAR)"
1230 PRINT
1240 PRINT"REGULAR IN SHAPE,BUT ONLY 200 CLUSTERS ARE KNOWN AND THE"
1250 PRINT"NEAREST 20000 LIGHT YEARS AWAY."
1260 GOTO 30
1270 PRINT"  COMETS"
1280 PRINT
1290 PRINT"LARGE RAREFIELD OBJECT TRAVELLING IN AN ELLIPTICAL ORBIT"
1300 PRINT"AROUND THE SUN.WHEN THE COMET IS AWAY FROM THE SUN THE TAIL"
1310 PRINT"IS NONEXISTENT.CERTAIN COMETS NEVER COME BACK.ONE SHORT"
1320 PRINT"PERIOD COMET,ENCKES COMET,GOES EACH 3.3 YEARS.THE ONLY"
1330 PRINT"BRIGHT COMET OF A PERIOD OF LESS THAN A CENTURY IS HALLEYS"
1340 PRINT"COMET WITH A PERIOD OF 76 YEARS"
1350 GOTO 30
1360 PRINT"  ESCAPE VELOCITIES"
1370 PRINT" EARTH   =  7.0 MPS
1380 PRINT" MERCURY =  2.6 MPS"
1390 PRINT" VENUS   =  6.4 MPS"
1400 PRINT" MARS    =  3.2 MPS"
1410 PRINT" JUPITER = 37.1 MPS"
1420 PRINT" SATURN  = 22.0 MPS"
1430 PRINT" URANUS  = 13.9 MPS"
1440 PRINT" NEPTUNE = 15.5 MPS"
1450 PRINT" PLUTO   =  ?
1460 PRINT
1470 PRINT" THE PLANETS"
1480 PRINT
1490 PRINT" PLANET    DISTANCE(MILS)  ROTATION    MASS   TEMPERATURE"
1500
1510 PRINT" MERCURY   36,000,000       88  DAYS    0.05      +770"
1520 PRINT" VENUS     67,000,000      277  DAYS    0.83      +800
1530 PRINT" EARTH     92,868,000      365  DAYS    1.0       +140"
1540 PRINT" MARS      141,500,000     687  DAYS    0.11      +85"
1550 PRINT" JUPITER   483,300,000     11.86 YRS.   318       -200"
1560 PRINT" SATURN    886,100,000     29.46 YRS.    95       -240"
1570 PRINT" URANUS    1,783,000000    84.01 YRS.    15       -310"
1580 PRINT" NEPTUNE   2,793,000000    164.79 YRS.   17       -360"
1590 PRINT" PLUTO     3,666,000000    248.43 YRS.   ?          ? "
1600 PRINT
1610 PRINT"  THE STARS"
1620 PRINT
1630 PRINT" STAR         LUMINOSITY  DISTANCE  TEMPERATURE   MOTION"
1640 PRINT" SIRIUS          27          9          2           -5"
1650 PRINT" CANOPUS      13740        230          1.3         +12"
1660 PRINT" RIGEL KENT       4          4          1           -14"
1670 PRINT" VEGA            56         27          2           -9"
1680 PRINT" CAPELLA        128         46          1           +19"
1690 PRINT" ARCTURUS       128         38          0.7         -3"
1700 PRINT" RIGEL        18000        500          4           +14"
1710 PRINT" PROCYON          6         11          1.3         -2"
1720 PRINT" ACHERNAR       222         73          4           +12"
1730 PRINT" HADAR,WAZN    1670        190          4           -3"
1740 PRINT" ALTAIR          23         16          2           -17"
1750 PRINT" BETELGEUSE    2900        280          0.5         +13"
1760 PRINT
```

A2.10

```
1720 PRINT" ACHERNAR      222          73          4          +12"
1730 PRINT" HADAR,WAZN   1670         190          4           -3"
1740 PRINT" ALTAIR         23          16          2          +17"
1750 PRINT" BETELGEUSE   2900         280          0,5        +13"
1760 PRINT
```

```
1770 PRINT"IN THIS GALAXY THERE ARE ABOUT 10↑11 STARS,THERE ARE POSSI"
1780 PRINT"-BLE 10↑12 GALAXIES IN THE UNIVERSE,THIS MEANS THERE ARE"
1790 PRINT"ABOUT 10↑23 STARS IN THE UNIVERSE,OR IN OTHER WORDS:"
1800 PRINT"100000000000000000000000 STARS"
1810 PRINT
1820 PRINT" MAGNITUDE              NUMBER OF STARS"
1830 PRINT
1840 PRINT"     1                                11"
1850 PRINT"     2                                41"
1860 PRINT"     3                               138"
1870 PRINT"     4                               530"
1880 PRINT"     5                             1 620"
1890 PRINT"     6                             4 850"
1900 PRINT"       VISIBLE STARS     =         7 190"
1910 PRINT
1920 PRINT"     7                            14 300"
1930 PRINT"     8                            41 000"
1940 PRINT"     9                           117 000"
1950 PRINT"    10                           324 000"
1960 PRINT"    11                           870 000"
1970 PRINT"    12                         2 270 000"
1980 PRINT"    13                         5 700 000"
1990 PRINT"    14                        13 800 000"
2000 PRINT"    15                        32 000 000"
2010 PRINT"    16                        11 000 000"
2020 PRINT"    17                       250 000 000"
2030 PRINT"    18                       296 000 000"
2040 PRINT"    19                       560 000 000"
2050 PRINT"    20                     1 000 000 000"
2060 PRINT"    21                     1 700 000 000"
2070 PRINT"          TOTAL    =       3 832 143 490"
2080 PRINT
2090 PRINT" THE EARTH SPINS AT 1000 PER HOUR AT THE EQUATOR"
2100 PRINT" THE EARTH TRAVELS AT 18 PER SECOND AROUND THE SUN"
2110 PRINT" THE GALAXY SPINS AT 170 PER SECOND"
2120 PRINT" THE COSMIC YEAR IS EQUAL TO  2*10↑7 EARTH YEARS"
2130 PRINT
2140 PRINT" EXTRA-GALACTIC NEBULAE"
2150 PRINT"CLASSIFICATION OF GALAXIES:"
2160 PRINT" E=(FOLLOWED BY A NUMBER 1 TO 10)THIS INDICATES THE AMOUNT"
2170 PRINT"OF FLATTENING"
2180 PRINT" S=(A,B+C) THIS INDICATES THE EXTENT TO WHICH THE ARMS(IF="
2190 PRINT"=ANY)OPEN OUT"
2200 PRINT" SB=THIS INDICATES THAT THE ARMS FORM A CLOSED LOOP"
2210 PRINT" IR=THIS INDICATES AN IRREGULAR GALAXY"
2220 PRINT
2230 PRINT"  QUASI-STELLAR OBJECTS"
2240 PRINT"THE BRIGHTNESS OF THESE QUASARS IS BRIGHTER THAN THE BRIGHT"
2250 PRINT"-EST GALAXY AND TRAVELLING AT 80 PER CENT THE SPEED OF "
2260 PRINT"LIGHT.DESPITE THEIR BRILLIANCE,THESE QUASARS ARE SMALL YET"
2270 PRINT"THEY APPEAR TO HAVE THE SAME DERIVITION AS A GALAXY,IT IS"
2280 PRINT"SUGGESTED THEY WERE ONCE GALAXIES THAT COLLAPSED UNDER ITS"
2290 PRINT"OWN GRAVITY CREATING A UNIQUE TYPE OF NUCLEAR EXPLOSION"
2300 PRINT
2310 PRINT"  THE CRAB NEBULA"
2320 PRINT" AN EXPANDING SUPERNOVA,EXPANDING AT A RATE OF 900 MPS AND"
2330 PRINT"AT A TEMPERATURE OF 36000 DEGREES F.IT IS 4100 LIGHT YEARS"
2340 PRINT"AWAY AND 6 LIGHT YEARS IN DIAMETER,IT HAS THE BROADCASTING"
```

```
2300 PRINT
2310 PRINT"  THE CRAB NEBULA"
2320 PRINT" AN EXPANDING SUPERNOVA,EXPANDING AT A RATE OF 900 MPS AND"
2330 PRINT"AT A TEMPERATURE OF 36000 DEGREES F.IT IS 4100 LIGHT YEARS"
2340 PRINT"AWAY AND 6 LIGHT YEARS IN DIAMETER.IT HAS THE BROADCASTING"
2350 PRINT"POWER OF 1000000000000000000000000000 WATTS OR 10↑24 KW."
2360 PRINT"DUE TO THE NEUTRON STAR NO BIGGER THAN 7 MILES INDIAMETER"



2370 PRINT
2380 PRINT"THE PLANETS(IN FULL)"
2390 PRINT"MERCURY:"
2400 PRINT"ONE AND A HALF TIMES AS LARGE AS THE MOON AND 200 MORE TIMES"
2410 PRINT"DISTANT.THE DISTANCE IS 28.6 MILLION MILES AT ITS PERIHELION"
2420 PRINT"AND 44.7 MILLION MILES AT ITS APHELION.THE POLAR AND EQUA"
2430 PRINT"-TORIAL DIAMETERS ARE EQUAL,THAT IS 3100 MILES.ITS DISTANCE"
2440 PRINT"FROM THE EARTH RANGES FROM 50 TO 137 MILLION MILES.THE SUN"
2450 PRINT"BAKED SIDE OF MERCURY IS 400 DEGREES C AND THE OTHER SIDE "
2460 PRINT"IS 100 DEGREES BELOW ZERO."
2470 PRINT"VENUS:"
2480 PRINT"200 MILES SHORTER DIAMETER THAN THE EARTH.26 MILLION MILES"
2490 PRINT"NEARER THE SUN THAN THE EARTH.DESPITE THE CLOUDS IT HAS "
2500 PRINT"A SURFACE TEMPERATURE OF 280 DEGREES C.TEMPERATURE OF THE "
2510 PRINT"UPPER ATMOSPHERE IS ABOUT -39 C.IN 1959 A BALLOON ASCENT"
2520 PRINT"PROVED THERE WAS AN ABUNDANCE OF WATER.THE VENUS-4 PROBE"
2530 PRINT"SHOWED THERE WAS A PRESSURE OF 1 ATMOSPHERE AT 16 MILES AND"
2540 PRINT"15 ATMOSPHERES AT GROUND LEVEL.ALSO THAT 75 PC OF THE VENUS"
2550 PRINT"-IAN ATMOSPHERE IS MADE OF CARBON DIOXIDE,2 PC OF OXYGEN,"
2560 PRINT"IF THERE IS ANY NITROGEN IT IS LESS THAN 7 PC.THE PRESENT"
2570 PRINT"PICTURE OF VENUS IS A BARREN DESERT NEARLY 3 TIMES AS HOT"
2580 PRINT"AS BOILING WATER,TOWARDS THE POLES THERE MAY BE BELTS OF "
2590 PRINT"TORRENTIAL BOILING HOT RAIN AND STANDING HOT SEAS,AT THE "
2600 PRINT"POLES THERE IS A POSSIBILITY OF SNOW"
2610 PRINT"MARS:"
2620 PRINT" A PLANET WITH 2 SATELLITES,PHOBOS AND DEIMOS,AT DISTANCES"
2630 PRINT"OF 3700 M AND 12500 M RESPECTIVELY.THE PERIHELION IS 128"
2640 PRINT"MILLION MILES,THE APHELION 155 MILLION MILES.IT HAS A DIA-"
2650 PRINT"METER OF 4200 MILES AND IS ONE SEVENTH THE EARTHS VOLUME."
2660 PRINT"MARS ROTATES IN 24 HOURS 37 MINUTES.THE SUMMER-EQUATORIAL"
2670 PRINT"TEMPERATURE MAY REACH 85 DEGREES F.THE BOILING TEMPERATURE"
2680 PRINT"OF WATER IS 77 DEGREES F.THE CANALS ARE NOW PROVED NOT TO"
2690 PRINT"WATER(AS THE MOONS SEAS).THE MARTIAN ATMOSPHERE CONSISTS"
2700 PRINT"OF,MAINLY,CARBON DIOXIDE,WITH NITROGEN,ARGON AND TRACES OF"
2710 PRINT"WATER VAPOUR.A STRANGE ATMOSPHERIC OCCURENCE IS A BLUE "
2720 PRINT"CLOUD WHICH HAS NOT BEEN ACCOUNTED FOR."
2730 PRINT
2740 PRINT"JUPITER:"
2750 PRINT"THE LARGEST PLANET IN THE SOLAR SYSTEM,WITH A DIAMETER OF"
2760 PRINT"11 TIMES THAT OF THE EARTH.ITS MASS IS 318 TIMES THAT OF "
2770 PRINT"THE EARTH AND 1/1047 OF THE SUN.THE EQUATORIAL DIAMETER IS"
2780 PRINT"88700 MILES AND A POLAR DIAMETER OF 83800 MILES BECAUSE IT"
2790 PRINT"ROTATES EVERY 9 HOURS 53 MINUTES.THE ANGLE OF INCLINATION"
2800 PRINT"IS 1 DEGREE.THE MOST UNUSUAL THING ABOUT JUPITER IS THE "
2810 PRINT"GREAT RED SPOT.ONCE BRICK RED BUT NOW PINK.THE ATMOSPHERE,"
2820 PRINT"THE JOVIAN ATMOSPHERE,CONSISTS OF HYDROGEN,METHANE AND AMM-"
2830 PRINT"ONIA,THE CLOUDS ARE PROBABLE AMMONIA.THE SURFACE TEMPERATURE"
2840 PRINT"OF THESE CLOUDS ABOUT -200 DEGREES F.THE ESTIMATED PRESS"
2850 PRINT"-URE OF JUPITER AT ITS CORE IS 60 MILLION ATMOSPHERES(420 "
2860 PRINT"THOUSAND TONS PER SQ INCH.) IT APPEARS THERE IS A STRIKING"
2870 PRINT"RELATIONSHIP BETWEEN JUPITER,EARTH AND ONE JUPITERS SATELL-"
2880 PRINT"ITES-IO.WHEN IO IS DIRECTLY BETWEEN THE EARTH AND JUPITER"
2890 PRINT"THERE IS AN INCREDIBLE OUTBURST OF POWER FROM JUPITER."
2900 PRINT"SATURN:"
2910 PRINT"A PLANET WITH A SURFACE TEMPERATURE OF -240 DEGREES F AND A"
2920 PRINT"DIAMETER 10 TIMES THAT OF THE EARTH.IT ROTATES ON ITS AXIS"
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2890 PRINT"THERE IS AN INCREDIBLE OUTBURST OF POWER FROM JUPITER.
2900 PRINT"SATURN:"
2910 PRINT"A PLANET WITH A SURFACE TEMPERATURE OF -240 DEGREES F AND A"
2920 PRINT"DIAMETER 10 TIMES THAT OF THE EARTH,IT ROTATES ON ITS AXIS"
2930 PRINT"ONCE EVERY 10.25 HOURS AND THERE IS ZA SLIGHT POLAR FLATTEN-"
2940 PRINT"ING.A GREAT AMOUNT OF THE ATMOSPHERE IS MADE OF METHANE AND"
2950 PRINT"HYDROGEN,THE CLOUDS ARE PROBABLE FROZEN DROPLETS OF METHANE"
2960 PRINT"AND AMMONIA.ITS LARGEST SATELLITE,TITIAN,HAS ITS OWN METHANE"
2970 PRINT"ATMOSPHERE.TITIAN IS 5 SIXTHS THE SIZE OF MARS.THE RINGS ARE"
2980 PRINT"9000 MILES FROM SATURNS SURFACE.THERE ARE THREE RINGS A+B"
2990 PRINT"WITH THE CASSINI DIVISION BETWEEN THEM,AND THE CREPE RING"
3000 PRINT"WHICH IS VERY FAINT.","3000"
3010 PRINT"URANUS:"
3020 PRINT"THE SEVENTH PLANET WITH A DIAMETER OF 32000 MILES.IT REVOL-"
3030 PRINT"VES AROUND THE SUN EVERY 84 YEARS AND ON ITS AXIS EVERY 10"
3040 PRINT"HOURS 45 MINUTES.ROTATING TWICE AS FAST AS THE EARTH THE"
3050 PRINT"EQUATORIAL BULGE IS 20 TIMES MORE PROMINENT,BUT IT IS ALMOST"
3060 PRINT"INVISIBLE BECAUSE THE AXIS INCLINATION IS 98 DEGREES.THE"
3070 PRINT"URANIAN ATMOSPHERE IS HYDROGEN AND METHANE AT A TEMPERATURE"
3080 PRINT"OF -310 DEGREES F."
3090 PRINT"NEPTUNE:"
3100 PRINT"THIS PLANET REVOLVES AROUND THE SUN EVERY 164.75 YEARS AND"
3110 PRINT"ON ITS AXIS EVERY 15 HOURS 48 MINUTES.SO IN THE NEPTURNIAN"
3120 PRINT"YEAR THERE ARE 90,000 DAYS.ITS DIAMETER IS 27600 MILES,42"
3130 PRINT"TIMES EARTHS VOLUME,BUT ONLY 17 TIMES AS MASSIVE AND ABOUT"
3140 PRINT"TWICE THE DENSITY OF WATER.THE NEPTUNIAN ATMOSPHERE CONSISTS"
3150 PRINT"MAINLY OF METHANE,HYDROGEN AND HELIUM,THE SURFACE CLOUDS"
3160 PRINT"TEMPERATURE IS -170 DEGREES C.BUT THE SMALL SOLID CORE MAY"
3170 PRINT"WELL BE HOT"
3180 PRINT"PLUTO:"
3190 PRINT"THE MOST REMOTE,KNOWN,PLANET IN THE SOLAR SYSTEM.ITS ORBIT"
3200 PRINT"IS VERY ECCENTRIC,THE PERIHELION IS 2750 MILLION MILES AND"
3210 PRINT"4500 MILLION MILES IS THE APHELION.THEREFORE AT ITS PERIHE-"
3220 PRINT"LION IT IS CLOSER TO THE SUN THAN NEPTUNE.IT COMPLETES ONE"
3230 PRINT"REVOLUTION OF THE SUN IN 248 YEARS 317 DAYS AND ITS ORBIT "
3240 PRINT"IS INCLINED AT 17 DEGREES,(SO THERE IS NO CHANCE OF PLUTO "
3250 PRINT"HITTING NEPTUNE.).WITH NO ATMOSPHERE TO SPEAK OF AND BEING"
3260 PRINT"SO REMOTE FROM THE SUN THE SURFACE TEMPERATURE IS -200 C."
3270 PRINT"IT IS THOUGHT QUITE PROBABLE THAT PLUTO WAS ONCE A SATELLITE"
3280 PRINT"OF NEPTUNE.IT WAS IN FACT DISCOVERED AS A RESULT OF MOVE"
3290 PRINT"-MENTS IN THE ORBIT OF NEPTUNE."
3300 PRINT
3310 PRINT" THE PLANETS SATELLITES"
3320 PRINT"  PLANET       NO. OF SATELLITES          NAMES"
3330 PRINT"  MERCURY              0                    -  "
3340 PRINT"   VENUS               0                    -  "
3350 PRINT"   EARTH               1                 MOON "
3360 PRINT"   MARS                2                 PHOBOS"
3370 PRINT"                                         DEIMOS"
3380 PRINT"   JUPITER            12                 AMALTHEA"
3390 PRINT"                                         IO"
3400 PRINT"                                         EUROPA"
3410 PRINT"                                         GANYMEDE"
3420 PRINT"                                         CALLISTO"
3430 PRINT"                                         VI"
3440 PRINT"                                         VII"
3450 PRINT"                                         X"
3460 PRINT"                                         XII"
3470 PRINT"                                         XI"
3480 PRINT"                                         VIII"
3490 PRINT"                                         IX"
3500 PRINT"   SATURN              10                TITAN"
3510 PRINT"                                         MIMAS"
```

```
3470 PRINT"                                                    XI"
3480 PRINT"                                                    VIII"
3490 PRINT"                                                    IX"
3500 PRINT"    SATURN              10                          TITAN"
3510 PRINT"                                                    MIMAS"
3520 PRINT"                                                    ENCELADUS"
3530 PRINT"                                                    TETHYS"
3540 PRINT"                                                    DIONE
3550 PRINT"                                                    RHEA"
3560 PRINT"                                                    HYPERION"



3570 PRINT"                                                    IAPETUS"
3580 PRINT"                                                    PHOEBE"
3590 PRINT"                                                    THEMIS"
3600 PRINT"    URANUS               5                          MIRANDA"
3610 PRINT"                                                    ARIEL"
3620 PRINT"                                                    UMBRIEL"
3630 PRINT"                                                    TITANIA"
3640 PRINT"                                                    OBERON"
3650 PRINT"    NEPTUNE              2                          TRITTON"
3660 PRINT"                                                    NEREID"
3670 PRINT"    PLUTO                0                           "  "
3680 PRINT
3690 PRINT
3700 PRINT" MASS INCREASE DUE TO SPEED"
3710 PRINT
3720 PRINT"MASS IS NOT A CONSTANT.IT VARIES WITH SPEED.TO WORK OUT THE"
3730 PRINT"INCREASED MASS OF AN OBJECT INPUT THE MASS OF THE OBJECT"
3740 PRINT"AND ITS VELOCITY";
3750 INPUT M,V
3760 LET C=(3X10↑10)
3770 LET Q=(SQR((V/C)↑2))/M
3780 PRINT Q
3790 PRINT" TERMS OF C    V IN M/S        MASS "
3800 PRINT"  0.25           46,500         1.04"
3810 PRINT"  0.5            93,000         1.16"
3820 PRINT"  0.9           167,400         2.3"
3830 PRINT"  0.99          184,140         7.0"
3840 PRINT"  1.0           186,273         INFINITE"
3850 PRINT
3860 PRINT"GRAVITY"
3870 PRINT"GRAVITATIONAL PULL OF TWO OBJECTS,INPUT THE TWO MASSES AND"
3880 PRINT"DISTANCE BETWEEN THEM"
3890 PRINT
3900 INPUT A,B,C
3910 PRINT
3920 LET Z=(A*B)/C
3930 PRINT  Z
3940 PRINT" EXPLANATION OF 4 ASTRONOMICAL TERMS(IN SHORT)"
3950 PRINT"PERIGEE:POINT NEAREST TO CENTRE OF ORBIT"
3960 PRINT"APOGEE:POINT FARTHEST TO CENTRE OF ORBIT"
3970 PRINT"ASCENDING NODE: ORBIT CUTTING AT EQUATOR"
3980 PRINT"DESCENDING NODE:ORBIT CUTTING AT POLES"
3990 GOTO 30
4000 END
```

SCHOOL 13 YEAR 2

```
LIST
 10   PRINT "  *******        *******        *******        ********"
 20   PRINT "  *******        *********      ********       *********"
 30   PRINT "  **             ****   ****    **   **        **    ****"
 40   PRINT "  *****          ****   ****    *********      **    ****"
 50   PRINT "  *****          ****   ****    *********      **    ****"
 60   PRINT "  ***            *********      **   **        *********"
 70   PRINT "  **             *******        **   **        ********"
 80   PRINT
 90   PRINT
 100  PRINT "                 *******        *******        *******        ********"
 110  PRINT "                 ********       *********      *******        *********"
 120  PRINT "                 ****           ****  ****     **  **         ****"
 130  PRINT "                 ****           *********      *******        ****"
 140  PRINT "                 ****           *********      *******        ****"
 150  PRINT "                 ****           ****  ****     **  **         ****"
 160  PRINT "                 ****           ****  ****     **  **           **"
 170  PRINT "                 ********       ****  ****     **  **         *******"
 180  PRINT "                 *******        ****  ****     **  **         ******"
 190  PRINT
 200  PRINT
 210  PRINT "                 *******        *******        ********"
 220  PRINT "                 *********      *******        ********"
 230  PRINT "                 ****  ****     **   **        ***"
 240  PRINT "                 *********      **   **        *********"
 250  PRINT "                 *********      *******        ********"
 260  PRINT "                 ****  ****     *******        ***"
 270  PRINT "                 ****  ****     **   **        ********"
 280  PRINT "                 ****  ****     **   **        ********"
 290  PRINT
 300  PRINT
 310  PRINT "   *******       *******        *******        *******        ********"
 320  PRINT "  ********       *******        *******        **********     ********"
 330  PRINT "  **             **   **        **             ****  ****       **"
 340  PRINT "  **   ****      *******        *******        ****  ****       **"
 350  PRINT "  **    **       **   **        *******        **********       **"
 360  PRINT "  ********       **   **        **             ****  ****       **"
 370  PRINT "   ******        **   **        *******        ****  ****       **"
 380  PRINT "    ****         **   **        *******        ****  ****       **"
 390  FOR D=1 TO 10
 400  PRINT
 410  NEXT D
 420  END

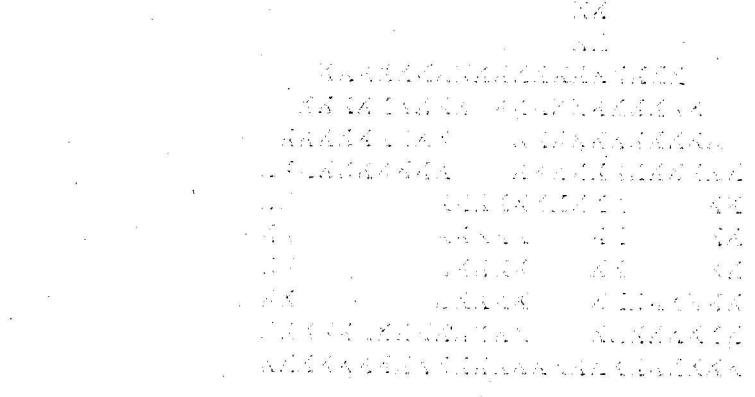
READY
```

SCHOOL 11 YEAR 1

```
LIST
5  REM THIS PROGRAM SHOULD DRAW A HOUSE!!
10   READ B,C,D
15   IF B=100 THEN 9999
20   FOR A=(B) TO (C).
30   PRINT TAB(A);"*";
40   NEXT A
50   IF D>0 THEN 10
60   PRINT
65   GOTO 10
70   DATA 17,13,0
80   DATA 17,14,0
90   DATA 4,22,0
100   DATA 3,11,1
110   DATA 13,23,0
120   DATA 2,10,1
130   DATA 14,24,0
140   DATA 1,10,1
150   DATA 14,25,0
160   DATA 1,2,1
170   DATA 10,19,1
180   DATA 24,25,0
190   DATA 1,2,1
200   DATA 10,14,1
205   DATA 18,19,1
220   DATA 24,25,0
230   DATA 1,2,1
240   DATA 15,14,1
250   DATA 18,19,1
260   DATA 24,25,0
265   DATA 1,2,1
270   DATA 10,14,1
280   DATA 15,25,0
290   DATA 1,14,1
300   DATA 18,25,0
310   DATA 1,25,0
9998   DATA 100,0,0
9999   END

READY
RUN
TRACE

READY
RUN
```



```
READY
```

SCHOOL 9 YEAR 3

```
NEW
010 REM D.SIMS
020 REM VALUE OF B12 AND B
030 PRINT SPC(9);"VALUE OF B↑2 AND B"
040 PRINT SPC(11);"B";SPC(12);"B↑2"
050 FOR L=1 TO 4
060 READ B,B↑2
070 DATA 2.7,6.95,3.78,10.01
080 LET V=B,B↑2
090 PRINT B,B↑2
100 NEXT L
110 END
RUN
```

```
NEW

020   PRINT"THIS PROGRAMME FINDS RECIPROCALS"
030   PRINT
040   PRINT"WHAT IS YOUR NUMBER";
050   INPUT N
060   IF N <> 0 THEN 90
070   PRINT"INFINITE"
080   GO TO 100
090   PRINT"RECIPROCALS OF"N;"IS"1/N
100   PRINT"DO YOU WANT TO PUT IN ANOTHER NUMBER"
110   PRINT"TYPE 1 FOR YES, 2 FOR NO
120   INPUT A
130   IF A = 1 THEN 040
140   IF A = 2 THEN 170
150   PRINT"ILLEGAL INPUT"
160   GO BACK 110
170   END
RUN
```

SCHOOL 13 YEAR 2

```
READY
 1  PRINT "THIS PROGRAMME WILL WORK OUT ANY OF THE FOLLOWING"
 2  PRINT "1)PYTHAGORAS' THEOREM          2)AREA OF A CIRCLE"
 3  PRINT "3)AREA OF A CYLINDER           4)VOLUME OF A CYLINDER"
 4  PRINT "5)CIRCUM.OF A CIRCLE           6)PERCENTAGES"
 5  PRINT "7)SQUARE AND CUBE ROOTS        8)AREA OF A TRIANGLE"
 6  PRINT "9)FRACTIONS TO GECIMALS    10)RATIO (1 TO ANOTHER NUMBER"
 7  PRINT "11)TEMPERATURES              12)SIMPLE AND COMPOUND INTEREST"
 8  PRINT
 9  PRINT "NOW INSERT NUMBER OF PROBLEM REQUIRED";
10   INPUT A
11   IF A=1 THEN 26
12   IF A=2 THEN 71
13   IF A=3 THEN 79
14   IF A=4 THEN 87
15   IF A=5 THEN 105
16   IF A=6 THEN 111
17   IF A=7 THEN 123
18   IF A=8 THEN 117
19   IF A=9 THEN 130
20   IF A=10 THEN 136
21   IF A=11 THEN 144
22   IF A=12 THEN 164
23   IF A>12 THEN 24
24   PRINT "YOU HAVE EXCEEDED THE LIMIT OF PROBLEMS"
25   GOTO 10
26   PRINT "  A*"
27   PRINT "   *  *"
28   PRINT "(C)*     *(B)"
29   PRINT "   *       *"
30   PRINT "  B**********C"
31   PRINT "       (A)"
32   PRINT
33   PRINT "ANGLE ABC=90 DEGREES"
34   PRINT
35   PRINT "IF YOU WISH TO FIND SIDE A PRINT 1"
36   PRINT "IF YOU WISH TO FIND SIDE B PRINT 2"
37   PRINT "IF YOU WISH TO FIND SIDE C PRINT 3"
38   INPUT B
39   IF B=1 THEN 45
40   IF B=2 THEN 55
41   IF B=3 THEN 61
42   IF B>3 THEN 43
43   PRINT "ONLY USE 1.2.3. NUMBERS PLEASE"
44   GOTO 38
45   PRINT "INSERT LENGTHS OF SIDES B AND C IN THIS ORDER"
46   INPUT C
47   INPUT D
48   IF C<D THEN 49
49   IF C>D THEN 52
50   PRINT "THE ANSWER RESULTS IN A NEGATIVE NUMBER"
51   GOTO 46
52   LET E=C*C-D*D
53   PRINT E↑(1/2)
54   GOTO 10
55   PRINT "INSERT LENGTHS OF A AND C IN THIS ORDER"
56   INPUT F
57   INPUT G
58   LET H=F*F+G*G
```

```
60  GOTO 10
61  PRINT "INSERT LENGTHS OF SIDES B AND A IN THAT ORDER"
62  INPUT I
63  INPUT J
64  IF I<J THEN 65
65  IF I>J THEN 68
66  PRINT "THE ANSWER RESULTS IN A NEGATIVE NUMBER"
67  GOTO 62
68  LET K=I*I-J*J
69  PRINT K↑(1/2)
70  GOTO 10
71  PRINT "INPUT PIE AS A DECIMAL ONLY"
72  PRINT "INSERT PIE HERE";
73  INPUT L
74  PRINT "NOW INPUT THE RADIUS HERE";
75  INPUT M
76  PRINT L*M*M
78  GOTO 10
79  PRINT "INPUT PIE AS A DECIMAL"
80  INPUT N
81  PRINT "INPUT THE RADIUS HERE";
82  INPUT O
83  PRINT "INPUT THE HEIGHT";
84  INPUT P
85  PRINT 2*N*O*P
86  GOTO 10
87  PRINT "FIRST INPUT PIE,IF IN DECIMAL 3,14 OR 22/7";
88  INPUT Q
89  PRINT "NOW INPUT THE RADIUS";
90  INPUT R
100  LET S=Q*R*R
101  PRINT "INPUT THE HEIGHT";
102  INPUT T
103  PRINT S*T
104  GOTO 10
105  PRINT "INPUT PIE AS A DECIMAL"
106  INPUT U
107  PRINT "INSERT THE RADIUS";
108  INPUT V
109  PRINT 2*U*V
110  GOTO 10
111  PRINT "FIRST INSERT SMALLER NUMBER";
112  INPUT W
113  PRINT "NOW INSERT LARGER NUMBER";
114  INPUT X
115  PRINT (W/X)*100"%"
116  GOTO 10
117  PRINT "INSERT THE HEIGHT";
118  INPUT Z
119  PRINT "INSERT THE BASE";
120  INPUT A2
121  PRINT (Z*A2)/2
122  GOTO 10
123  PRINT "INSERT NUMBER OF WHICH THE ROOTS ARE TO BE FOUND";
124  INPUT Y
125  PRINT "SQUARE ROOT"
126  PRINT Y↑(1/2)
127  PRINT Y↑(1/3)
128  PRINT "CUBE ROOT ABOVE"
129  GOTO 10
```

```
130  PRINT "FIRST INSERT THE NUMERATOR";
131  INPUT B2
132  PRINT "FIRST INSERT THE DENOMINATOR";
133  INPUT C2
134  PRINT B2/C2
135  GOTO 10
136  PRINT "INSERT THE NUMERATOR";
137  INPUT D2
138  PRINT "INSERT THE DENOMINATOR";
139  INPUT E2
140  PRINT D2/D2
141  PRINT E2/D2
142  PRINT "THIS APPEARS IN FRACTION FORM"
143  GOTO 10
144  PRINT "IF YOU WISH TO CONVERT CENTIGRADE TO FAHRENHEIT PRESS1"
145  PRINT "IF YOU WISH TO CONVERT FAHRENHEIT TO CENTIGRADE PRESS2"
146  INPUT G2
147  IF G2=1 THEN 152
148  IF G2=2 THEN 158
149  IF G2>2 THEN 150
150  PRINT "MAKE UP YOUR MIND"
151  GOTO 146
152  PRINT "INSERT CENTIGRADE TEMPERATURE";
153  INPUT H2
154  LET I2=H2*9
155  LET J2=I2/5
156  PRINT J2+32
157  GOTO 10
158  PRINT "INSERT FAHRENHEIT TEMPERATURES";
159  INPUT K2
160  LET L2=K2-32
161  LET M2=L2*5
162  PRINT M2/9
163  GOTO 10
164  PRINT "DO YOU WANT COMPOUND OR SIMPLE? PRESS 1 FOR COM 2 FOR SIM"
165  INPUT N2
166  IF N2=1 THEN 180
167  IF N2=2 THEN 171
168  IF N2>2 THEN 169
169  PRINT "ONLY USE 1 OR 2"
170  GOTO 165
171  PRINT "INSERT MONEY IN PENCE";
172  INPUT O2
173  PRINT "INSERT RATE IN PERCENTAGE";
174  INPUT P2
175  PRINT "INSERT TIME IN YEARS";
176  INPUT Q2
177  LET R2=O2*P2*Q2
178  PRINT R2/100
179  GOTO 10
180  PRINT "INSERT MONEY IN PENCE";
181  INPUT S2
182  PRINT "INSERT RATE IN PERCENTAGE";
183  INPUT T2
184  PRINT "ON ONE YEAR, THE INTEREST WILL BE"
185  LET U2=S2*T2
186  PRINT U2/100
187  PRINT "FOR EACH YEAR,INSERT ABOVE NUMBER UNDER MONEY IN PENCE"
188  PRINT "IF YOU WISH TO FIND ANOTHER YEAR, PRESS 1, IF NOT PRESS 2"
189  INPUT V2
190  IF V2=1 THEN 180
```

```
184  PRINT "ON ONE YEAR, THE INTEREST WILL BE"
185  LET U2=S2*T2
186  PRINT U2/100
187  PRINT "FOR EACH YEAR,INSERT ABOVE NUMBER UNDER MONEY IN PENCE"
188  PRINT "IF YOU WISH TO FIND ANOTHER YEAR, PRESS 1, IF NOT PRESS 2'
189  INPUT V2
190  IF V2=1 THEN 180
191  IF V2=2 THEN 10
192  IF V2>2 THEN 189
193  GOTO 10
194  END
READY
```

SCHOOL 13 YEAR 2

```
    PRINT "PROGRAM TRANSLATES LATIN INTO ENGLISH"
    PRINT
50  PRINT "INPUT 1 FOR PRESENT TENSE FIRST CONJUGATION VERBS ,"
60  PRINT "      2 FOR PRESENT TENSE  2ND  CONJUGATION VERBS ,"
70  PRINT " 3 FOR 1ST DECLENSION NOUNS , 4 FOR 2ND DECLENSION NOUNS,"
80  PRINT " DOMINUS,MAGISTER & PUER TYPES, 5 FOR 3RD DECL. NOUNS ,"
90  PRINT " 6 FOR THE TENSES , 7 FOR ADJECTIVES , BONUS,NIGER,TENER,"
100  PRINT " 8 FOR THE CASE SYSTEM , 9 FOR THE LOCATIVE CASE "
110  PRINT " 10 FOR SUM IN ALL TENSES"
120  PRINT "      FOR VOCABULARY INPUT 5 ,RETURN , INPUT 10"
130  INPUT A
140  PRINT
150  IF A=1 THEN 260
160  IF A=2 THEN 1380
170  IF A=3 THEN 1720
180  IF A=4 THEN 980
190  IF A=5 THEN 4660
200  IF A=6 THEN 2120
210  IF A=7 THEN 4020
220  IF A=8 THEN 2980
230  IF A=9 THEN 4710
240  IF A=10 THEN 4760
250  PRINT
260  PRINT "INPUT 50 FOR STEM MEANINGS & 200 FOR ENDINGS"
270  PRINT "WHEN ANYTHING HAS COME UP THAT YOU WANTED - STOP ME AFTER"
280  INPUT Z
290  IF A=50 THEN 320
300  IF A=100 THEN 820
310  PRINT
315  GOTO 260
320  PRINT "AMARE = TO LOVE,NAVIGARE = TO SAIL,EXSPECTARE = TO EXPECT"
330  PRINT "AMBULARE = TO WALK,ERRARE = TO WANDER,OCCUPARE = TO SEIZE"
340  PRINT "VOLARE = TO FLY,VASTARE = TO RAVAGE,STARE = TO STAND"
350  PRINT "IUVARE = TO HELP,CENARE = TO DINE,CULPO = TO BLAME"
360  PRINT "LABORARE = TO WORK,AEDIFICARE = TO BUILD,ARARE = TO PLOUGH"
370  PRINT "SUPERARE = TO CONQUER,EXPLORARE = TO EXPLORE"
380  PRINT "PROPERARE = TO HURRY,DESPERARE=TO DESPAIR,NATARE=TO SWIM"
390  PRINT "OPPUGNARE = TO ATTACK,SPECTARE = TO LOOK AT,PORTARE ="
400  PRINT "TO CARRY,DELECTARE = TO PLEASE,CLAMARE = TO SHOUT"
410  PRINT "PUGNARE = TO FIGHT,PARARE = TO PREPARE,MONSTRARE =TO SHOW"
420  PRINT "POSTULARE = TO DEMAND,CELARE = TO HIDE,SECARE = TO CUT"
430  PRINT "SUPPEDITARE = TO SUPPLY,HABITARE = TO INHABIT,CURARE ="
440  PRINT "TO LOOK AFTER,NECARE = TO KILL,SALUTARE = TO GREET"
450  PRINT "CONSERVARE = TO KEEP SAFE,VITARE = TO AVOID,REPORTARE ="
460  PRINT "TO WIN,COMPARARE = TO OBTAIN,DARE = TO GIVE,APPROPINQUARE"
470  PRINT "= TO APPROACH,PROPULSARE = TO DRIVE BACK,IACTARE = TO HURL"
480  PRINT "FUGARE = TO ROUT,INSTARE = TO THREATEN,REVOCARE ="
490  PRINT "TO CALL BACK,VIGILARE = TO BE AWAKE,VULNERARE = TO WOUND"
500  PRINT "PERTERBARE = TO THROW INTO CONFUSION,GUBERNARE = TO STEER"
510  PRINT "LIBERARE = TO FREE,EXCITARE = TO ROUSE,ADORARE=TO WORSHIP"
520  PRINT "HIEMARE = TO SPEND THE WINTER,REFORMIDARE = TO DREAD,"
530  PRINT "NUNTIARE=TO ANNOUNCE,COLLOCARE=TO ESTABLISH,CONVOCARE"
540  PRINT "= TO CALL TOGETHER,CREMARE=TO BURN,FATIGARE = TO TIRE"
560  PRINT "PRAESTARE = TO OFFER,OSTENTARE = TO DISPLAY,MANDARE ="
570  PRINT "TO ENTRUST,TRANSPORTARE = TO CARRY ACROSS,INCITARE ="
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ii

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560  PRINT "TO ENCOURAGE,NARRARE = TO TELL,CONSECRARE = TO DEDICATE,"
590  PRINT "CONSILIARE = TO WIN OVER,ARMARE = TO ARM,CONFIRMARE ="
600  PRINT "TO STRENGTHEN,CONCIRCUMDARE = TO SURROUND,POTARE=TO DRINK"
610  PRINT "DORMITARE - TO FALL ASLEEP,SEPARARE = TO SEPARATE"
620  PRINT "INDICARE = TO BETRAY,RESONARE = TO ECHO,RECIPERARE ="
630  PRINT "TO RECOVER,IMMOLARE = TO SACRIFICE,EVOLARE = TO FLY BACK"
640  PRINT "DEVORARE = TO DEVOUR,SPERARE = TO HOPE FOR,NOSCITARE ="
650  PRINT "TO RECOGNISE,EXPUGNARE = TO TAKE BY STORM,REGNARE ="
670  PRINT "FLAGITARE = TO DEMAND,ORARE = TO BEG,ROGARE = TO ASK"
680  PRINT "ADMINISTRARE = TO GOVERN,SPECTARE AD=TO FACE,PENETRARE ="
690  PRINT "TO PENETRATE,TRUCIDARE = TO BUTCHER,IGNORARE = TO NOT KNOW"
700  PRINT "PEREQUITARE = TO DRIVE ABOUT,EVOLARE = TO SPRING FORTH,"
710  PRINT "IURARE = TO SWEAR,TARDARE= TO DELAY,CERTARE=TO STRIVE"
720  PRINT "IMPORTARE = TO INPORT,REPUDIARE=TO REJECT,INVITARE "
730  PRINT "=TO INVITE,COGITARE = TO THINK OF,IMPERARE = TO COMMAND,"
740  PRINT "SANARE=TO CURE,APTARE = TO FIT"
745  PRINT
750  PRINT
760  PRINT "IF YOU WANT THE ENDINGS INPUT 100 - THE REST 500!"
770  PRINT
780  INPUT Z
790  IF Z=100 THEN 820
800  IF Z=500 THEN 50
810  GOTO 50
820  PRINT
830  PRINT "    ***   PRESENT TENSE   ***    "
840  PRINT
850  PRINT " AMO = I LOVE , I DO LOVE OR I AM LOVING "
860  PRINT
870  PRINT " AMAS = YOU(S) LOVE , YOU DO LOVE OR YOU ARE LOVING "
880  PRINT
890  PRINT " AMAT = HE/SHE/IT LOVES , - DOES LOVE OR - IS LOVING"
900  PRINT
910  PRINT " AMAMUS = WE LOVE , WE DO LOVE QR WE ARE LOVING "
920  PRINT
930  PRINT " AMATIS = YOU(PL) LOVE , YOU ARE LOVING, WE DO LOVE"
940  PRINT
950  PRINT " AMANT = THEY LOVE, THEY DO LOVE, THEY ARE LOVING"
960  PRINT
970  GOTO 50
980  PRINT
990  PRINT
1000  PRINT
1010  PRINT "INPUT 1000 FOR(US) TYPE NOUNS, 2000 FOR(ER) TYPE & 3000"
1020  PRINT "                FOR (PUER) TYPE "
1030  INPUT H
1040  IF H=3000 THEN 1330
1050  IF H=2000 THEN 1280
1060  IF H=1000 THEN 1080
1070  GOTO 50
1080  PRINT "AMICUS = FRIEND,CAMPUS = PLAIN,CAPTIVUS = PRISONER,DEUS =".
1090  PRINT "GOD,DOMINUS = MASTER (OF HOUSE),FILIUS = SON,FLUVIUS ="
1100  PRINT "RIVER,GLADIUS = SWORD,LOCUS = PLACE,MURUS = WALL,OCULUS="
1110  PRINT "EYE,POPULUS = PEOPLE,PROPINQUUS=RELATIVE,SERVUS=SLAVE"
1120  PRINT "SOCIUS = ALLY,HUMUS = HUMAN,PRAEFECTUS=LEADER,NIMBUS ="
1130  PRINT "RAIN-CLOUD,EQUUS = HORSE,INIMICUS = ENEMY,CIBUS = FOOD,"
1140  PRINT "ANIMUS = WIT - MIND,CASUS = FALL."
1150  PRINT
1160  WAIT (5000)
1170  PRINT
1180  PRINT "INPUT 111 FOR ER TYPE NOUNS,112 FOR PUER TYPES AND"
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1190  PRINT "          113 TO START AGAIN"
1200  PRINT
1210  INPUT L
1220  IF L=111 THEN 1260
1230  IF L=112 THEN 1320
1240  IF L=113 THEN 50
1250  GOTO 1210
1260  PRINT
1270  WAIT (5000)
1280  PRINT "MAGISTER=SCHOOLMASTER,AGER=FIELD,LIBER=BOOK, FABER ="
1290  PRINT "WORKMAN"
1300  PRINT
1310  GOTO 1170
1320  PRINT
1330  PRINT "PUER = BOY,GENER = SON-IN-LAW,VESPER = EVENING,SOCER ="
1340  PRINT "LIBERI = CHILDREN (PL ONLY),CHILDREN, VIR = MAN"
1350  PRINT
1360  WAIT (5000)
1370  GOTO 50
1380  PRINT
1390  PRINT "INPUT 248 FOR ENDINGS & 150 FOR STEMS "
1400  PRINT
1410  INPUT R
1420  IF R=148 THEN 1450
1430  IF R=150 THEN 1600
1440  GOTO 50
1450  PRINT
1460  PRINT " MONEO = I WARN,AM WARNING OR DO WARN, MONES = YOU "
1470  PRINT " WARN,ARE WARNING OR DO WARN, MONET = HE WARNS, DOES"
1480  PRINT " WARN OR IS WARNING, MONEMUS = WE WARN, DO WARN "
1490  PRINT " OR ARE WARNING, MONETIS = YOU (PL) WARN, YOU ARE "
1500  PRINT " WARNING OR YOU DO WARN, MONENT=THEY WARN, DO WARN OR ARE"
1510  PRINT " WARNING "
1520  PRINT
1530  PRINT " INPUT 67 FOR STEMS & 68 TO RE-START "
1540  PRINT
1550  INPUT A
1560  IF A=67 THEN 1590
1570  IF A=68 THEN 50
1580  GOTO 50
1590  PRINT
1600  PRINT "MONERE=TO WARN, MANERE=TO REMAIN, HABERE=TO HAVE,"
1610  PRINT "TENERE=TO HOLD, TIMERE=TO FEAR, AUGERE=TO INCRESE"
1620  PRINT "IACERE=TO LIE, TERRERE=TO FRIGHTEN, RIDERE=TO LAUGH"
1630  PRINT "VIDERE=TO SEE, RESPONDERE=TO REPLY, DELERE=TO "
1640  PRINT "DESTROY, EXERCERE=TO TRAIN, TACERE=TO BE SILENT,"
1650  PRINT "REMOVERE=TO WITHDRAW,SUSTINERE=TO ENDURE,"
1670  PRINT "MOVERE-TO MOVE, NOCERE=TO BE HARMFUL, PARERE=TO "
1680  PRINT "OBEY, PLACERE=TO PLEASE, PRAEBERE=TO OFFER,"
1690  PRINT "INVIDERE=TO OFFER, LATERE=TO LIE HIDDEN, VALERE ="
1700  PRINT "TO AVAIL "
1710  GOTO 50
1720  PRINT
1730  PRINT " THE CASE SYSTEM IS NOT SHOWN IN THIS SECTION "
1740  PRINT
1750  WAIT (5000)
1760  PRINT "ALL NOUNS OF 1ST DECLENSION ARE FEMININE "
1770  PRINT
1780  PRINT "PUELLA=GIRL, REGINA=QUEEN, INCOLA=NATIVE          "
1790  PRINT "FEMINA=WOMAN, LUNA=MOON, FILIA=FAUGHTER, VACCA  "
1800  PRINT "=COW, AGRICOLA=FARMER, CASA=COTTAGE, SILVA=WOOD  "
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1810  PRINT "STELLA=STAR, MENSA=TABLE, VILLA=HOUSE, NAVICULA "
1820  PRINT "= A LITTLE BOAT, CENA=DINNER, TERRA=LAND, INSULA ="
1830  PRINT "ISLAND, FORTUNA=FORTUNE, VIA=WAY, ORA=SHORE,     "
1840  PRINT "PECUNIA=MONEY, EPISTOLA=LETTER, AQUA=WATER,      "
1850  PRINT "SABRINA=RIVER SEVERN, UMBRA=SHADE, HERBA=GRASS,"
1860  PRINT "PLAGA=TRAP, FERA=BEAST, ITA=SO, ANCORA=ANCHOR  "
1870  PRINT "ANCILLA=MAIDSERVANT, SAGITTA=ARROW, VICTORIA =  "
1880  PRINT "VICTORY, COPIA(E)=TROOP(S), HASTA=SPEAR, PRAEDA="
1890  PRINT "BOOTY, ESSEDA=CHARIOT, ADVENA=FOREIGNER, BRITANNIA"
1900  PRINT "  =BRITAIN, PROCELLA=STORM, PATRIA=COUNTRY, VITA="
1910  PRINT "LIFE, GALLINA=HEN, ITALIA=ITALY, PORTA=GATE,     "
1920  PRINT "FOSSA=DITCH, PUGNA=FIGHT, DEA=GODDESS, FABULA=   "
1930  PRINT "STORY, IANUA=DOOR, TAEERNA=SHOP, COLONIA=COLONY,"
1940  PRINT "BALNEA=BATH, AVARITIA=GREED, IRA=ANGER, AMICITIA"
1950  PRINT "=FRIENDSHIP, TURBA=CROWD, DOMINA=MISTRESS, MEMORIA"
1960  PRINT "=MEMORY, INIURIA=WRONG, CALEDONIA=SCOTLAND,       "
1970  PRINT "NATURA=NATURE, STATUA=STATUE, ROMA=ROME, ARA =    "
1980  PRINT "ALTAR, GALLIA=FRANCE, PERFUGA=FUGATIVE, GALEA =   "
1990  PRINT "HELMET, TAEDA=TORCH, VENIA=PARDON, DEXTRA=RIGHT-"
2000  PRINT "HAND, FLAMMA=FLAME, CATENA=CHAIN, BENOVOLENTIA ="
2010  PRINT "KINDNESS, SPELUNCA=CAVE, UNGULA=HOOF, LATERBRA ="
2020  PRINT "HIDING-PLACE, CLAVA=CLUB, AQUILLA=EAGLE, PLUVIA="
2030  PRINT "RAIN, DEVA=CHESTER, DUBRA=DOVER, MELITA=MALTA,   "
2040  PRINT "SENTENTIA=OPINION, MATRONA=LADY, IUSTITIA=JUSTICE"
2050  PRINT "GLORIA=RENOWN, PROVINCIA=PROVINCE, LUXURY=LUXURIA,"
2060  PRINT "EPULA=FEAST, ALA=A WING OF CAVALRY, SINISTRA=LEFT"
2070  PRINT "MODESTIA=MODERATION, ROTA=WHEEL, TURMA=SQUADRON,"
2080  PRINT "AURIGA=CHARIOTEER, FUGA=ESCAPE, CAUSA=REASON,    "
2090  PRINT "CUSTODIA=CONFINEMENT, PALMA=PALM OF HAND, SAPENTIA"
2100  PRINT "=WISDOM "
2110  GOTO 50
2120  PRINT
2130  PRINT "    ***    THE   TENSES                ***  "
2140  PRINT
2150  PRINT " *** INPUT  222 FOR PRESENT,333 FOR IMPERFECT,444 FOR ***"
2160  PRINT " *** FUTURE, 555 FOR PERFECT, 666 FOR PLUPERFECT & 777 ***"
2170  PRINT " *** FOR FUTURE PERFECT ***"
2180  PRINT
2190  INPUT Q
2200  IF Q=222 THEN 2280
2210  IF Q=333 THEN 2430
2220  IF Q=444 THEN 2540
2230  IF Q=555 THEN 2650
2240  IF Q=666 THEN 2770
2250  IF Q=777 THEN 2880
2260  PRINT " INPUT A VALID INPUT PLEASE "
2280  PRINT
2290  PRINT "   AMARE          MONERE           SUM      "
2300  PRINT "   -------        --------         -----    "
2320  PRINT "    AMAS           MONES           ES       "
2330  PRINT "    AMAT           MONET           EST      "
2340  PRINT "  AMAMUS           MONEMUS         SUMUS    "
2350  PRINT "  AMATIS           MONETIS         ESTIS    "
2360  PRINT "   AMANT           MONENT          SUNT     "
2370  PRINT
2380  PRINT " INPUT  6 TO RESTART, 7 TO USE OTHER TENSES "
2390  INPUT F
2400  IF F=6 THEN 50
2410  IF F=7 THEN 2150
2420  GOTO 50
2430  PRINT
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2440  PRINT "    AMARE          MONERE          SUM          "
2450  PRINT "    -------        --------        -----        "
2460  WAIT (3000)
2470  PRINT "    AMABAM         MONEBAM         ERAM         "
2480  PRINT "    AMABAS         MONEBAS         ERAS         "
2490  PRINT "    AMABAT         MONEBAT         ERAT         "
2500  PRINT "   AMABAMUS       MONEBAMUS       ERAMUS        "
2510  PRINT "   AMABATIS       MONEBATIS       ERATIS        "
2520  PRINT "    AMABANT        MONEBANT        ERANT        "
2530  GOTO 2380
2540  PRINT
2550  PRINT "    AMARE          MONERE          SUM          "
2560  PRINT "    -------        --------        -----        "
2570  WAIT (3000)
2580  PRINT "     AMABO          MONEBO          ERO          "
2590  PRINT "    AMABAS         MONEBAS         ERAS         "
2600  PRINT "    AMABAT         MONEBAT         ERAT         "
2610  PRINT "   AMABAMUS       MONEBAMUS       ERAMUS        "
2640  GOTO 2380
2650  PRINT
2660  PRINT "    AMARE          MONERE          SUM          "
2670  PRINT "    -------        --------        -----        "
2680  PRINT
2690  WAIT (3000)
2700  PRINT "     AMAVI          MONUI           FUI          "
2710  PRINT "   AMAVISTI       MONUISTI        FUISTI        "
2720  PRINT "    AMAVIT         MONUIT          FUIT         "
2730  PRINT "   AMAVIMUS       MONUIMUS        FUIMUS        "
2740  PRINT "   AMAVISTIS      MONUISTIS       FUISTIS       "
2750  PRINT "   AMAVERUNT      MONUERUNT       FUERUNT       "
2760  GOTO 2380
2770  PRINT
2780  PRINT "    AMARE          MONERE          SUM          "
2790  PRINT "    -------        --------        -----        "
2800  WAIT (3000)
2810  PRINT "    AMAVERAM       MONUERAM        FUERAM       "
2820  PRINT "    AMAVERAS       MONUERAS        FUERAS       "
2830  PRINT "    AMAVERAT       MONUERAT        FUERAT       "
2840  PRINT "   AMAVERAMUS     MONUERAMUS      FUERAMUS      "
2850  PRINT "   AMAVERATIS     MONUERATIS      FUERATIS      "
2860  PRINT "    AMAVERANT      MONUERANT       FUERANT      "
2870  GOTO 2380
2880  PRINT "    AMARE          MONERE          SUM          "
2890  PRINT "    ------         --------        -----        "
2900  WAIT (3000)
2910  PRINT "     AMAVERO        MONUERO         FUERO        "
2920  PRINT "    AMAVERIS       MONUERIS        FUERIS       "
2930  PRINT "    AMAVERIT       MONUERIT        FUERIT       "
2940  PRINT "   AMAVERIMUS     MONUERIMUS      FUERIMUS      "
2950  PRINT "   AMAVERITIS     MONUERITIS      FUERITIS      "
2960  PRINT "   AMAVERINT      MONUERINT       FUERINT       "
2970  GOTO 2380
2980  WAIT (5000)
2990  PRINT
3000  PRINT
3010  PRINT "***  THE CASE SYSTEMS  ***"
3020  PRINT
3030  PRINT " INPUT  0.5 FOR 1ST DECL., 0.6 FOR 2ND DECL.& 0.7 FOR 3RD"
3040  PRINT "                DECLENSION"
3050  INPUT N
3060  IF N=.5 THEN 3100
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3070  IF N=.6 THEN 3450
3080  IF N=.7 THEN 3840
3090  GOTO 50
3100  PRINT
3110  PRINT "INPUT 1 FOR NOMINATIVE,2 FOR VOCATIVE,3 FOR ACCUSATIVE,  "
3120  PRINT "  4 FOR GENETIVE,5 FOR DATIVE AND 6 FOR ABLATIVE "
3130  PRINT
3140  INPUT M
3150  IF M=1 THEN 3220
3160  IF M=2 THEN 3300
3170  IF M=3 THEN 3330
3180  IF M=4 THEN 3360
3190  IF M=5 THEN 3390
3200  IF M=6 THEN 3420
3210  GOTO 3100
3220  PRINT "  NOMINATIVE :  SING   MENSA :  PLURAL  MENSAE "
3230  PRINT
3240  PRINT "INPUT ONE FOR DIFFERENT DECL.,2 FOF CASE, 3 TO RESTART"
3250  INPUT P
3260  IF P=1 THEN 3020
3270  IF P=2 THEN 3100
3280  IF P=3 THEN 50
3290  GOTO 50
3300  PRINT
3310  PRINT "  VOCATIVE : SINGULAR MENSA  : PLURAL MENSAE "
3320  GOTO 3230
3330  PRINT
3340  PRINT "  ACCUSATIVE : SINGULAR MENSAM : PLURAL MENSAS"
3350  GOTO 3230
3360  PRINT
3370  PRINT "  GENETIVE : SINGULAR  MENSAE  : PLURAL MENSARUM"
3380  GOTO 3230
3390  PRINT
3400  PRINT "  DATIVE : SINGULAR MENSAE : PLURAL MENSIS "
3410  GOTO 3230
3420  PRINT
3430  PRINT "  ABLATIVE : SINGULAR MENSA : PLURAL MENSIS "
3440  GOTO 3230
3450  PRINT
3460  PRINT "  INPUT: 1 NOMINATIVE,2 VOCATIVE,3 ACCUSATIVE,4 GENETIVE,"
3470  PRINT "  5 DATIVE, 6 ABLATIVE"
3480  PRINT
3490  WAIT (2000)
3500  INPUT D
3510  IF D=1 THEN 3580
3520  IF D=2 THEN 3680
3530  IF D=3 THEN 3710
3540  IF D=4 THEN 3740
3550  IF D=5 THEN 3770
3560  IF D=6 THEN 3800
3570  GOTO 50
3580  PRINT
3590  PRINT "  NOMINATIVE : SING. DOMINUS, MAGISTER, PUER "
3600  PRINT "               : PLUR. DOMINI , MAGISTRI, PUERI"
3610  GOTO 3620
3620  PRINT "  INPUT: 1 FOR DIFFERENT DECL.,2 FOR CASE AND 3 FOR RESTA."
3630  INPUT H
3640  IF H=1 THEN 3020
3650  IF H=2 THEN 3450
3660  IF H=3 THEN 50
3670  GOTO 50
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3680  PRINT " VOCATIVE : SING.   DOMINE  , MAGISTER , PUER "
3690  PRINT "            : PLUR.   DOMINI  , MAGISTRI   PUERI"
3700  GOTO 3620
3710  PRINT "ACCUSATIVE: SING.   DOMINUM , MAGISTRUM, PUERUM"
3720  PRINT "            : PLUR.   DOMINOS , MAGISTROS, PUEROS"
3730  GOTO 3620
3740  PRINT " GENETIVE  : SING.   DOMINI  , MAGISTRI , PUERI "
3750  PRINT "            : PLUR. DOMINORUM ,MAGISTRORUM , PUERORUM"
3760  GOTO 3620
3770  PRINT " DATIVE : SING. : DOMINO : MAGISTRO : PUERO "
3780  PRINT "          : PLUR. : DOMINIS : MAGISTRIS : PUERIS "
3790  GOTO 3620
3800  PRINT " ABLATIVE : SING : DOMINO : MAGISTRO : PUERO"
3810  PRINT "            : PLUR : DOMINIS : MAGISTRIS : PUERIS "
3820  GOTO 3620
3830  PRINT
3840  PRINT "         REX       MILES     CONSUL      LEO"
3850  PRINT "        -----     -------   --------     -----"
3860  WAIT (3000)
3870  PRINT "SINGULAR"
3880  PRINT "         REX       MILES     CONSUL      LEO"
3890  PRINT "         REX        MILES     CONSUL      LEO"
3900  PRINT "         REGEM     MILITEM   CONSULEM    LEONEM"
3910  PRINT "         REGIS     MILITIS   CONSULIS    LEONIS"
3920  PRINT "         REGI      MILITI    CONSULI     LEONI"
3930  PRINT "         REGE      MILITE    CONSULE     LEONE"
3940  PRINT "PLURAL"
3950  PRINT "         REGES     MILITES   CONSULES    LEONES"
3960  PRINT "         REGES     MILITES   CONSULES    LEONES"
3970  PRINT "         REGES     MILITES   CONSULES    LEONES"
3980  PRINT "         REGUM     MILITUM   CONSULUM    LEONUM"
3990  PRINT "         REGIBUS   MILITIBUS CONSULIBUS  LEONIBUS"
4000  PRINT "        REGIBUS   MILITIBUS CONSULIBUS  LEONIBUS"
4010  GOTO 3620
4020  PRINT
4030  PRINT "          *** ADJECTIVES *** "
4040  PRINT
4050  PRINT " INPUT 1 FOR BONUS 2 FOR NIGER & 3 FOR TENER "
4060  PRINT
4070  INPUT S
4080  IF S=1 THEN 4120
4090  IF S=2 THEN 4330
4100  IF S=3 THEN 4510
4110  GOTO 4050
4120  PRINT " MASCULINE          FEMININE          NEUTER "
4130  PRINT
4140  PRINT "  BONUS              BONA              BONUM "
4150  PRINT "  BONE               BONA               BONUM "
4160  PRINT "  BONUM              BONAM              BONUM "
4170  PRINT "  BONI               BONAE              BONI  "
4180  PRINT "  BONO               BONAE              BONO  "
4190  PRINT "  BONO               BONA               BONO  "
4200  PRINT "  BONI               BONAE              BONA  "
4210  PRINT "  BONI               BONAE             BONA  "
4220  PRINT "  BONOS              BONAS              BONA  "
4230  PRINT "  BONORUM            BONARUM            BONORUM"
4240  PRINT "  BONIS              BONIS              BONIS  "
4250  PRINT "  BONIS              BONIS              BONIS  "
4260  PRINT
4270  PRINT " ENTER 1 TO SELECT OTHER SECTION, 2 TO RESTART"
4280  PRINT
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4250  INPUT J
4300  IF J=2 THEN 50
4310  IF J=1 THEN 4040
4320  GOTO 50
4330  PRINT " MASCULINE          FEMININE          NEUTER"
4340  PRINT ""
4350  PRINT "  NIGER              NIGRA             NIGRUM "
4360  PRINT "  NIGER              NIGRA             NIGRUM "
4370  PRINT "  NIGRUM             NIGRAM            NIGRUM "
4380  PRINT "  NIGRI              NIGRAE            NIGRI  "
4390  PRINT "  NIGRO              NIGRAE            NIGRO  "
4400  PRINT "  NIGRO              NIGRA             NIGRO  "
4410  PRINT "  NIGRI              NIGRAE            NIGRA  "
4420  PRINT "  NIGRI              NIGRAE            NIGRA  "
4430  PRINT "  NIGROS             NIGRAS            NIGRA  "
4440  PRINT "  NIGRORUM           NIGRARUM          NIGRORUM "
4450  PRINT "  NIGRIS             NIGRIS            NIGRIS "
4460  PRINT "  NIGRIS             NIGRIS            NIGRIS "
4470  GOTO 4260
4480  WAIT (2000)
4490  PRINT
4500  WAIT (2000)
4510  PRINT " MASCULINE          FEMININE          NEUTER"
4520  PRINT
4530  PRINT " TENER              TENERA            TENERUM "
4540  PRINT " TENER              TENERA            TENERUM "
4550  PRINT " TENERUM            TENERAM           TENERUM "
4560  PRINT " TENERI             TENERAE           TENERI  "
4570  PRINT " TENERO             TENERAE           TENERO  "
4580  PRINT " TENERO             TENERA            TENERO  "
4590  PRINT " TENERI             TENERAE           TENERI  "
4600  PRINT " TENERI             TENERAE           TENERI  "
4610  PRINT " TENEROS            TENERAS           TENEROS "
4620  PRINT " TENERORUM          TENERARUM         TENERORUM "
4630  PRINT " TENERIS            TENERIS           TENERIS "
4640  PRINT " TENERIS            TENERIS           TENERIS "
4650  GOTO 4260
4660  PRINT " FOR ENDINGS INPUT 1, FOR MEANINGS IN VOCABULARY  10 "
4670  INPUT O
4680  IF O=1 THEN 3830
4690  IF O=10 THEN 5120
470000  GOTO 4660
4710  PRINT "    *** LOCATIVE CASE ***"
4730  PRINT " 1ST DECL. SING. = ENDING AE , PLUR. IS "
4740  PRINT " 2ND DECL. PLUR. = ENDING I  , PLUR. IS "
4750  GOTO 50
4760  PRINT
4770  PRINT "  *** THE VERB SUM *** "
4780  PRINT
4790  PRINT " PRESENT ";" FUTURE   ";" IMPERFECT "
4800  PRINT ""
4810  PRINT "  SUM     ";"  ERO     ";"  ERAM     "
4820  PRINT "  ES      ";"  ERIS    ";"  ERAS     "
4830  PRINT "  EST     ";"  ERIT    ";"  ERAT     "
4840  PRINT "  SUMUS   ";"  ERIMUS  ";"  ERAMUS   "
4850  PRINT "  ESTIS   ";"  ERITIS  ";"  ERATIS   "
4860  PRINT "  SUNT    ";"  ERUNT   ";"  ERUNT    "
4870  GOTO 4980
4880  PRINT
4890  PRINT " PERFECT ";" FUTURE    ";" PLUPERFECT"
4900  PRINT "         ";" PERFECT   ";"            "
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4910  PRINT "          ";" "
4920  PRINT " AMAVI    ";" AMAVERO    ";" AMAVERAM   "
4930  PRINT " AMAVISTI ";" AMAVERIS   ";" AMAVERAS   "
4940  PRINT " AMAVIT   ";" AMAVERIT   ";" AMAVERAT   "
4950  PRINT " AMAVIMUS ";" AMAVERIMUS ";" AMAVERAMUS "
4960  PRINT " AMAVISTIS";" AMAVERITIS";" AMAVERATIS "
4970  PRINT " AMAVERUNT";" AMAVERUNT ";" AMAVERUNT "
4980  PRINT
4990  PRINT
5000  PRINT
5010  PRINT " PERFECT  ";" FUTURE    ";" PLUPERFECT  "
5020  PRINT "          ";" PERFECT   ";"               "
5030  PRINT " "
5040  PRINT " "
5050  PRINT "  FUI     ";"  FUERO    ";"  FUERAM      "
5060  PRINT "  FUISTI  ";"  FUERIS   ";"  FUERAS      "
5070  PRINT "  FUIT    ";"  FUERIT   ";"  FUERAT      "
5080  PRINT "  FUIMUS  ";"  FUERIMUS ";"  FUERAMUS    "
5090  PRINT "  FUISTIS ";"  FUERITIS ";"  FUERATIS    "
5100  PRINT "  FUERUNT ";"  FUERUNT  ";"  FUERANT     "
5110  GOTO 50
5120  PRINT
5130  PRINT "     *** VOCABULARY *** "
5140  PRINT
5150  PRINT " FOR WORDS BEGINNING WITH(A) INPUT 1, (B) INPUT 2 AND SO- "
5160  PRINT
5170  INPUT F
5180  IF F=1 THEN 5460
5190  IF F=2 THEN 5760
5200  IF F=3 THEN 5820
5210  IF F=4 THEN 6070
5220  IF F=5 THEN 6200
5230  IF F=6 THEN 6300
5240  IF F=7 THEN 6390
5250  IF F=8 THEN 6440
5260  IF F=9 THEN 6510
5270  IF F=10 THEN 5700
5280  IF F=11 THEN 5700
5290  IF F=12 THEN 6680
5300  IF F=13 THEN 6780
5310  IF F=14 THEN 6910
5320  IF F=15 THEN 7010
5330  IF F=16 THEN 7070
5340  IF F=17 THEN 7160
5350  IF F=18 THEN 7200
5360  IF F=19 THEN 7290
5370  IF F=20 THEN 7370
5380  IF F=21 THEN 7400
5390  IF F=22 THEN 7430
5400  IF F=23 THEN 5700
5410  IF F=24 THEN 5700
5420  IF F=25 THEN 5700
5430  IF F=26 THEN 5700
5440  GOTO 50
5450  PRINT
5460  PRINT " AB (WITH ABL.) = FROM, ABSTINEO = I SPARE, ABSUM = I AM"
5470  PRINT " AWAY, ACER = KEEN, ACIES = LINE OF BATTLE, AD (WITH "
5480  PRINT " ACC.) = TO, ADHIBEO = I APPLY, ADHUC = STILL,"
5490  PRINT " ADMINISTRO = I GOVERN, ADORO = I WORSHIP, ADSUM = I AM "
5500  PRINT " PRESENT, ADVENA=FOREIGNER, ADVENTUS = ARRIVAL,"
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5510  PRINT " ADVERSUS (WITH ACC.) AGAINST, AEDIFICO = I BUILD "
5520  PRINT " AEGER = SICK, AEGROTO = I AM ILL, AENEUS = OF BRONZE "
5530  PRINT " AES = MONEY, ACER = FIELD, AGRICOLA = FARMER, ALA = "
5540  PRINT " WING OF CAVALRY, ALACER = ACTIVE, ALBUS = WHITE, "
5550  PRINT " ALIQUANDUI = FOR SOME TIME, ALIQUOT=SOME, ALTUS=DEEP"
5560  PRINT " AMBO = BOTH, AMBULO = WALK, AMICITIA = FRIENDSHIP,"
5570  PRINT " AMICUS = FRIEND, AMO = I LOVE, AMOR = LOVE, AMPHORA ="
5580  PRINT " WINE JAR, AUGEO= I INCREASE, AUREUS=GOLDEN, AURIGA"
5590  PRINT
5600  PRINT " = CHARIOTEER, ANCILLA = MAIDSERVANT, ANIMAL = ANIMAL,"
5610  PRINT " ANIMUS = MIND, ANNUS = YEAR, ANSER = GOOSE, ANTE (WITH"
5620  PRINT " ACC ) = BEFORE, ANTIQUUS = ANCIENT, ANTRUM = CAVE, "
5630  PRINT " ANULUS = RING, APPAREO = I APPEAR, APPELLO=I CALL,"
5640  PRINT " APPROPINQUO = I APPROACH, APTO= I FIT, APUD (WITH ACC)"
5650  PRINT " = AT THE HOUSE OF, AQUA = WATER, ARA = ALTAR, ARMA = "
5660  PRINT " WEAPONS, ARMATUS = ARMED, ARMILLA=BRACELET, ARMO = "
5670  PRINT " I ARM, ARO = I PLOUGH, ASPER = ROUGH, AUDEO = I DARE,"
5680  PRINT " AURUM = GOLD, AUXILIUM = HELP, AVARITIA = GREED"
5690  PRINT " "
5700  PRINT " FOR ANOTHER SECTION ENTER 1, FOR RESTART ENTER 2 "
5710  INPUT Y
5720  IF Y=1 THEN 5150
5730  IF Y=2 THEN 50
5740  GOTO 50
5750  PRINT
5760  PRINT " BALNERE = BATHS, BELLUM = WAR, BENE = WELL, BENEFICIUM"
5770  PRINT " = BENEFIT, BENOVOLENTIA = KINDNESS, BESTIA = BEAST,"
5780  PRINT " BLANDUS = COAXING, BONUS = GOOD, BRACCHIUM =-ARM,"
5790  PRINT " BRITANNIA = BRITAIN "
5800  GOTO 5700
5810  PRINT
5820  PRINT " CAELUM = SKY, CALCAR = SPUR, CALEDONIA = SCOTLAND,"
5830  PRINT " CAPTIVUS = PRISONER, CASA = COTTAGE, CASTRUM = FORT,"
5840  PRINT " CASUS = FALL, CATENA = CHAIN, CAUDA = TAIL, CAUSA ="
5850  PRINT " CAUSE, CAVEO = I AM ON MY GUARD, CAVERNA = CAVE, "
5860  PRINT " CELEBER = FAMOUS, CELEBRO = I CELEBRATE, CELER = QUICK,"
5870  PRINT " CELO = I HIDE, CENA = DINNER, CENO = I DINE, CERTO ="
5880  PRINT " I STRIVE, CERTUS = FIXED, CETERI = THE REST, CIBUS ="
5890  PRINT " FOOD, CIRCUM (WITH ACC.) = ROUND, CIRCUMDO = I SURROUND"
5900  PRINT " CIRCUMSPECTO = I LOOK ROUND AT, CIRCUMSTO = I STAND "
5910  PRINT " ROUND, CLAM = SECRETELY, CLAMO = I SHOUT, CLARUS ="
5920  PRINT " CLEAR, CLAVA = CLUB, CLIVUS = HILL, CLOACA = SEWER,"
5930  PRINT " COGITO = I THINK OF, COLLOCO = I ESTABLISH, COLLOQUIUM"
5940  PRINT " = CONFERENCE, COLONIA = COLONY, COMMUNICO = I SHARE,"
5950  PRINT " COMPARO = I OBTAIN, COMPORTO = I COLLECT, CONCILLIO ="
5960  PRINT " I WIN OVER, CONCILLIUM = COUNCIL, CONFIRMO = I STRENG-"
5970  PRINT " THEN, CONSECRO = DEDICATE, CONSERVO = I CONSERVE, "
5980  PRINT " CONSILIUM = ADVISE, CONSUL = CONSUL, CONTRA (WITH ACC.)="
5990  PRINT " AGAINST, CONUBIUM = MARRIAGE, CONVOCO = I CALL "
6000  PRINT " TOGETHER, COPIAE = TROOPS, CORONO = I CROWN ,CORPUS "
6010  PRINT " = BODY, COTIDIANUS = DAILY, COTIDIE = EVERY DAY, CRAS "
6020  PRINT " = TOMORROW, CREMO = I BURN, CULPO = I BLAME, CUM "
6030  PRINT " (WITH ABLATIVE) = WITH, CUNICULUS = TUNNEL, CUR = WHY? "
6040  PRINT " CURA = CARE, CURIA = SENATE HOUSE, CURO = I LOOK AFTER,"
6050  PRINT " CUSTODIA = CONFINEMENT "
6060  GOTO 5700
6070  PRINT " DAMNO = I CONDEMN, DEA = GODDESS, DEBEO = I OUGHT, "
6080  PRINT " DEFESSUS = TIRED OUT, DEINDE = NEXT, DELECTO = I PLEASE"
6090  PRINT " DELECTUS = CHOSEN, DELEO = I DESTROY, DEMONSTRO = I "
6100  PRINT " PROVE, DEMULCEO = I LICK, DENIQUE = AT LAST, DENSUS = "
6110  PRINT " THICK, DESECO = I CUT OFF, DESERTUS = DESERTED, "
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6120  PRINT " DESIDERO = I MISS, DESPERO = I DESPAIR, DETURBO = I "
6130  PRINT " THROW DOWN, DEUS=GOD, DEVORO=I DEVOUR, DEXTER = RIGHT "
6140  PRINT " DIGITUS = FINGER, DIRUS = TERRIBLE, DISPLICEO = I "
6150  PRINT " DISPLEASE, DIU = FOR A LONG TIME, DO = I GIVE, DOCEO ="
6160  PRINT " I TEACH, DOMICILIUM = HOME, DOMINA = MISTRESS, DOMITUS"
6170  PRINT " = MASTER, DONUM = GIFT, DORMITO = I FALL ASLEEP, DUM ="
6180  PRINT " WHILE, DUO = TWO, DUX = LEADER "
6190  GOTO 5700
6200  PRINT " E , EX (WITH ABL.) = FROM, EGO = I, ELEPHANTUS = ELE- "
6210  PRINT " PHANT, ENIM = FOR, EPISTOLA = LETTER, EPULA = FEAST, "
6220  PRINT " EQUES = HORSEMAN, EQUUS = HORSE, ERRO = I WANDER, "
6230  PRINT " ESSEDA = A WAR - CHARIOT, ET = AND, ETIAM = EVEN, "
6240  PRINT " EVOCO = I CALL OUT, EXCITO = ROUSE, EXCLAMO = I SHOUT "
6250  PRINT " OUT, EXERCEO = I TRAIN, EXERCITUS = ARMY, EXITIUM = "
6260  PRINT " DESTRUCTION, EXPLORO = I EXAMINE, EXPECTO = I EXPECT, "
6270  PRINT " EXPIRO = I DIE, EXSULTO = I BOAST, EXTRA (WITH ACC.) = "
6280  PRINT " OUTSIDE."
6290  GOTO 5700
6300  PRINT " FABER = WORKMAN, FABULA - STORY, FATIGO = I TIRE,"
6310  PRINT " FEMINA = WOMAN, FERA = BEAST, FERE = ALMOST, FERRUM = "
6320  PRINT " IRON SWORD, FESSUS = TIRED, FESTINO = I HURRY, FILIA ="
6330  PRINT " DAUGHTER, FILIUS = SON, FLAGITO = I DEMAND, FLAMMA = "
6340  PRINT " FLAME, FLUVIUS = RIVER, FORTE - BY CHANCE, FORTUNA = "
6350  PRINT " FORTUNE, FORUM = MARKET, FOSSA = DITCH, FRATER = "
6360  PRINT " BROTHER, FRUMENTUM = CORN, FUGA = ESCAPE, FUGO = I "
6370  PRINT " ROUT, FUNDO = I POUR."
6380  GOTO 5700
6390  PRINT " GALEA - HELMET, GALLIA = FRANCE, GALLINA = HEN, GLADI-"
6400  PRINT "US = SWORD, GLOBUS = BAND, GLORIA = RENOWN, GRAECIA = "
6410  PRINT " GREECE, GRATUS = WELCOME, GREX - FLOCK, GUBERNO = I "
6420  PRINT " STEER, GLEVUM = GLOUSTER."
6430  GOTO 5700
6440  PRINT " HABEO = I HAVE, HABITO = I INHABIT, HAEREO = I STICK, "
6450  PRINT " HASTA = SPEAR, HERBA = GRASS, HIC = HERE, HIEMO = I "
6460  PRINT " SPEND THE WINTER, HIO = I GAPE, HODIE = TODAY, HOMO = "
6470  PRINT " MAN, HONESTUS = HONOURABLE, HONORO = I HONOUR, HORA = "
6480  PRINT " HOUR, HOSPITIUM = HOSPITALITY, HUMANUS = HUMAN."
6490  GOTO 5700
6500  PRINT
6510  PRINT " IACTO = I HURL, IACEO = I LIE, IAM = NOW, IANUA = DOOR"
6520  PRINT " IBI = THERE, IGITUR = THEREFORE, IGNORO = I DON'T KNOW "
6530  PRINT " IMMOLO = I SACRIFICE, IMPERIUM = POWER, IMPERO = I "
6540  PRINT " COMMAND, IMPETUS = ATTACK, IMPLEO = I FILL, IMPORTO = "
6550  PRINT " I IMPORT, IN (WITH ACC.) = INTO, IN (WITH ABLATIVE)= IN"
6560  PRINT " OR ON, INCITO = I ROUSE, INCOLA = NATIVE, INDE = THEN,"
6570  PRINT " INDICO = I SHOW, INFESTUS = HOSTILE, INIMICUS = ENEMY,"
6580  PRINT " INIQUUS = UNEVEN, INIUSTUS = UNJUST, INSIDEO = I SIT ON"
6590  PRINT " INSIDIAE = AMBUSH, INSTO = I THREATEN, INSULA = ISLAND,"
6600  PRINT " INTER(WITH ACC.) = AMONG, INTERDUM=SOMETIMES, INTERIM ="
6610  PRINT " MEANWHILE, INTERVALLUM = DISTANCE, INTRO = I ENTER,"
6620  PRINT " INVICEM = IN TURN, INVIDEO = I ENVY, INVITO = I INVITE,"
6630  PRINT " IRA = ANGER, IRATUS = ANGRY, ITA = SO, ITAQUE = "
6640  PRINT " THEREFORE, ITERUM = AGAIN, IUBEO = I ORDER, IURO = I "
6650  PRINT " SWEAR, IUSTITIA = JUSTICE, IUSTUS = JST, IUVO = I "
6660  PRINT " HELP"
6670  GOTO 5700
6680  PRINT " LABEFACTO = I DESTROY, LABORO = I WORK, LAETUS = GLAD,"
6690  PRINT " LAEVUS = LEFT, LATEBRAE = HIDING-PLACE, LATEO = I LIE"
6700  PRINT " HID, LATRO = ROBBER, LATUS = SIDE, LATUS=BROAD, LAUDO"
6710  PRINT " = I PRAISE, LEGATUS = AMBASSADOR, LEO = LION, LEVO = "
6720  PRINT " I LIFT, LEX = LAW, LIBER = BOOK, LIBER = FREE, LIBERI"
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6730  PRINT " CHILDREN, LIBERO = I FREE, LINGUA = LANGUAGE, LOCO = "
6740  PRINT " I PLACE, LOCUS = PLACE, LONGUS = LONG, LORICA = BREAST"
6750  PRINT " PLATE,LUDUS = GAME, LUNA = MOON, LUXURIA = LUXURIA "
6760  PRINT
6770  GOTO 5700
6780  PRINT " MAESTUS = SAD, MAGISTER = MASTER, MAGNUS = GREAT, "
6790  PRINT " MANDO = I ENTRUST, MANE = IN THE MORNING, MANEO = I "
6800  PRINT " REMAIN, MANUS = HAND, MATRIMONIUM = MARRIAGE, MATURUS "
6810  PRINT " = RIPE, MAXIMUS = VERY BIG, MEDICINA = REMEDY, MEDICUS"
6820  PRINT " = DOCTOR, MEMBRUM = LIMB, MENSA = TABLE, MEUS = MY "
6830  PRINT " MIGRO = I MOVE, MILES = SOLDIER, MINISTRO = I SERVE OUT"
6840  PRINT " MIRACULUM = WONDER, MIRUS = STRANGE, MITIGO = I SOFTEN "
6850  PRINT " MITTO = I SEND, MODO = ONLY, MODUS = WAY, MOMENTUM = "
6860  PRINT " = MOMENT, MONEO = I WARN, MONSTRO = I SHOW, MORA = "
6870  PRINT " DELAY, MORIBUNDUS = DYING , MORTUUS = DEAD, MOVED = I "
6880  PRINT " MOVE, MOX = SOON, MULCO = I BEAT, MURUS = WALL, "
6890  PRINT " MUSICA = MUSIC "
6900  GOTO 5700
6910  PRINT " NARRO = I TELL, NATO = I SWIM, NATURA = NATURE, NAUTA "
6920  PRINT " = SAILOR, NAVICULA = LITTLE BOAT, NAVIGO = I SAIL, "
6930  PRINT " NEBULA = MIST, NECO = I KILL, NIGER = BLACK, NIHIL ="
6940  PRINT " NOTHING, NIMBUS = RAIN-CLOUD, NISI = UNLESS, NON = NOT"
6950  PRINT " NONUS = NINTH, NOSTER = OR, NOTO = I NOTE, NOTUS = "
6960  PRINT " WELL-KNOWN, NOVUS = NEW, NOX = NIGHT, NUMERUS = "
6970  PRINT " NUMBER, NUNTIO = I ANNOUNCE."
6980  WAIT (1)
6990  PRINT
7000  GOTO 5700
7010  PRINT " OB = BECAUSE, OBSECRO = I BESEECH, OBTINEO = I HOLD "
7020  PRINT " OCCUPO = I SEIZE, OCULUS = EYE, OLEUM = OIL, OMNINO ="
7030  PRINT " ALTOGETHER, OPPIDUM = TOWN, OPPUGNO = I ATTACK, ORA ="
7040  PRINT " SHORE, ORNO = I EQUIP, ORO = I BEG, OSTENTO = I "
7050  PRINT " DISPLAY, OMNIS = ALL "
7060  GOTO 5700
7070  PRINT " PAENE = ALMOST, PALMA - PALM, PARATUS = READY, PAREO ="
7080  PRINT " I OBEY, PARO = I PREPARE, PARUUS = SMALL, PATER = "
7090  PRINT " FATHER, PATRIA = COUNTRY, PECUNIA = MONEY, PERFUGA = "
7100  PRINT " FUGATIVE, PERICULUM = DANGER, PLAGA = TRAP, PLUVIA = "
7110  PRINT " RAIN, POMUM = APPLE, PORTA = GATE, PORTO = I CARRY "
7120  PRINT " POSTULO = I DEMAND, POTIUS = RATHER, POTO = I DRINK, "
7130  PRINT " PRADA = BOOTY, PROCELLA = STORM, PROELIUM = BATTLE , "
7140  PRINT " PROPERO = I HURRY, PUELLA = GIRL, PUGNA = BATTLE "
7150  GOTO 5700
7160  PRINT " QUAM = THEN, QUANDAM = ALTHOUGH, QUARTUS = FOURTH, "
7170  PRINT " QUATTOR = FOUR, QUO ? = WHITHER ?, QUOD = BECAUSE, "
7180  PRINT " QUONDAM = ONCE, QUOQUE = ALSO, QUOT ? = HOW MANY ? "
7190  GOTO 5700
7200  PRINT " RECENSEO = I REVIEW, RECIPERO = I RECOVER, RECUSO = "
7210  PRINT " I REFUSE, REFORMIDO = I DREAD, REGINA = QUEEN, REGIUS "
7220  PRINT " = ROYAL, REGNO = I REIGN, REGNUM = DINGDON, REMOVEO = "
7230  PRINT " I REMOVE, REPORTO = I WIN, REPUDIO = I REJECT, RESONO "
7240  PRINT " = I ECHO, RESPONDEO = I REPLY, RETINEO = KEEP, RETRO ="
7250  PRINT " BACKWARDS, REVOCO = I CALL BACK, REX = KING, RIDEO = "
7260  PRINT " I LAUGH, RIPA = BANK, ROGO = I ASK, ROTA = WHEEL, "
7270  PRINT " RURSUS = AGAIN, RUINA = FALL "
7280  GOTO 5700
7290  PRINT " SAGITTA = ARROW, SALUTO = I GREET, SANO = I CURE, "
7300  PRINT " SAXUM = PEBBLE, SCUTUM = SHIELD, SECO = I CUT, SED=BUT"
7310  PRINT " SEMPER = ALWAYS, SEPARO = I SEPARATE, SERVUS = SLAVE "
7320  PRINT " SI = IF, SIC = SO, SICCO = I DRY, SIGNUM = SIGNAL, "
7330  PRINT " SILVA = WOOD, SOCIUS = ALLY, SOL = SUN, SPECTO = I "
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7340  PRINT " WATCH, SPELUNCA = CAVE, STELLA = STAR, STO = I STAND "
7350  PRINT " SUM = I AM, SUPERO = I CONQUER, SUSTINEO = I ENDURE "
7360  GOTO 5700
7370  PRINT " TABERNA = SHOP, TENEO = I HOLD, TERRA = LAND, TIMEO = "
7380  PRINT " I FEAR, TURBA = CROWD, TUTUS = SAFE "
7390  GOTO 5700
7400  PRINT " UBI = WHERE, UMBRA = SHADE, UNA = TOGETHER, UNDA = "
7410  PRINT " WAVE, UNGULA = HOOF "
7420  GOTO 5700
7430  PRINT " VACCA = COW, VIR = MAN, VOLO = I FLY "
7440  GOTO 5700
7450  END
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SCHOOL 12 YEAR 6

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LIST

 10 REM SILL PLAYING PSD
 20 PRINT "HELLO I'M [illegible]"
 30 INPUT N$
 40 LET A=1
 50 PRINT "WELL";N$;",DO YOU WANT TO DO A QUIZ"
 60 PRINT "DO YOU LIKE SHELLY OR JACKIE"
 70 INPUT A$
    IF A$="J" THEN 90
 80 PRINT "GOOD.MY NAME IS JOE. WHAT'S YOUR FAVOURITE"
100 LET I=I+1
110 PRINT "WHAT COLOUR IS A LIVE LOBSTER"
120 INPUT B$
130 IF B$="BLUE" THEN 150
140 IF B$<>"BLUE" THEN 150
150 PRINT "NO I'M AFRAID YOU'RE WRONG. A LIVE LOBSTER IS BLUE"
155 PRINT "WHY DON'T WE TRY THE NEXT QUESTION"
170 GO TO 200
180 PRINT "WELL JOHN.HERE IS ANOTHER QUESTION"
190 LET A=A+1
200 LET I=I+1
210 PRINT "WHAT IS THE CAPITAL CITY OF FINLAND";
220  INPUT D$
230 IF D$="HELSINKI" THEN 260
240 IF D$<>"HELSINKI" THEN 250
250 PRINT "SORRY,THAT IS WRONG.HELSINKI IS THE RIGHT ANSWER";
260 PRINT "ANYWAY HERE IS QUESTION NUMBER"
270 GO TO 330
280 PRINT "GOOD.THAT WAS RIGHT THE ANSWER IS"
290 LET A=A+1
300 LET I=I+1
310 PRINT "WHAT IS THE OPPOSITE OF PESSIMISM";
320 INPUT B$
330 IF B$="OPTIMISM" THEN 350
340 IF B$<>"OPTIMISM" THEN 360
350 PRINT "OPTIMISM IS THE LIKELY TO BE.HAVE A GO AT"
360 PRINT "ANOTHER ONE"
370 GO TO 410
380 PRINT "MY OPPONENT HAS NO SHOULD GET THAT RIGHT WAS WELL";
390 PRINT "SO HERE'S A QUESTION FOR YOUR"
400 LET A=A+1
410 LET I=I+1
420 PRINT "GIVE THE ABBREVIATION FOR THE USSR"
430 PRINT "WHO WILLIAM SHAKESPEARE'S [illegible]"
440 INPUT B$
450 IF B$="RUSSIA" THEN 470
460 IF B$<>"RUSSIA" THEN 480
470 PRINT "NO. ILLEGAL SUBSTITUTE . [illegible] AND SATURDAY";
480 PRINT "PERHAPS YOU WILL BE ABLE TO GET THE NEXT ONE RIGHT"
490 GO TO 500
500 PRINT "IN-TO [illegible] ALREADY YOU SHOULDN'T KNOW";
510 PRINT "BECAUSE YOU'VE GOT TWELVE IN A ROW"
520 LET A=A+1
530 LET I=I+1
540 PRINT "WHAT DO THE INITIALS V.C. STAND FOR "
550 INPUT C$
560 IF C$="VICTOR IA CROSS" THEN 590
570 PRINT "V.C. STANDS FOR VICTORIA CROSS"
580 GO TO 610
590 PRINT "GOOD.IN OLDEN TO ANSWER THAT"
600 LET A=A+1
610 PRINT "WELL,";A$;"YOU HAVE NOW COMPLETED THE QUIZ";
620 PRINT "AND YOU HAVE SCORED ";A;" OUT OF";I
630 IF I>A THEN 650
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APPENDIX 3

ACCOUNT OF A CONFERENCE HELD BY THE COMPUTER EDUCATION GROUP ON COMPUTER EDUCATION IN SCHOOLS

Computer Education in Schools —
A conference held by the Computer Education Group of the British Computer Society at St. Catherine's College, Oxford from 15 - 17th March 1972.

The impact of computer education is beginning to reach most schools. The aim of this conference was to help in achieving an understanding of the current situation, planning for the future and the implications of future developments in schools.

A series of papers was presented on the ways and means by which computer education is being achieved in schools, the relationship between computers and other academic disciplines, syllabus content, examinations, teacher training, and computers in educational administration and technology. There was ample opportunity for discussion on all these and many other topics.

The introduction was given by Dr. H. L. W. Jackson, Chairman of the Computer Education Group. Dr. Jackson is Head of the Faculty of Mathematics, Statistics and Computing at the North Staffordshire Polytechnic. He gave an account of how a group of enthusiasts had the foresight to realise that computing must be accepted as part of the main school curriculum, and how, in December 1965, they formed the Computer Education Group with

affiliation to the British Computer Society. The Group is an informal co-operative organisation for teachers and others interested in the use of computers for teaching in educational establishments. The success of the Group is its informality and the willingness of its members to help one another.

The main aims of the Group are to spread knowledge in the field, to give aid to one another and to provide a body which can approach other organisations with authority. These objectives are being partially fulfilled by the provision of the journal "Computer Education" published once a term to nearly 3,000 members (700 overseas) and by the formation of local branches (at present there are twenty-two in existence which form the core of the computer education movement. The Group is represented on most other bodies which have an interest in computer education in schools and colleges.

Dr. Jackson went on to describe some of the set-backs and achievements of the Group in the past, and its hopes for the future. As part of these provisions an important area is computer education in schools. The Conference Committee were delighted with the positive response from such eminent and busy people offering their assistance to achieve the aims of the Conference.

The State of the Art.

Mr. D. Conway, Secretary of the Computer Education Group.

Mr. Conway is a Principal Lecturer in Computing at the North Staffordshire Polytechnic, Stafford. He described how computer education has progressed since the first programming courses were given to sixth formers in the early 1950's. We now have a full range of courses in all branches of the educational system, schools, colleges of education, colleges of further education, polytechnics and universities. The forms of course vary widely being vocational and non-vocational, specialist and non-specialist, brief appreciation courses and intensive training. It is important to see how the school work fits into the overall pattern.

In school, the most important type of course is the general appreciation course aimed at the whole population. Such a course is designed to educate the future users of computer systems and to make sure that the human elements of large scale information processing systems will be active. At the present time most of the major problems, both political and technical, arise as a result of people's ignorance and fear. The

country's future economic well-being depends on our exploitation of computers and thus it is important that everyone can play an active rather than a passive role. It has been found that these courses can be mounted early in the secondary school curriculum.

The other major development has been in the area of computer applications where mathematics has played a dominant role. Most of this work has been based in the sixth form but has recently spread into lower forms. There has also been some diversification involving other subject areas such as Physics, Music and Geography. Most recently there has been some development in the vocationally orientated sphere which has been stimulated mainly by the raising of the school leaving age. Some of these developments have crystallised into examination courses, the most notable being the 'A' level in Computer Science and more recently mode 3 C.S.E. syllabuses for Computer Studies.

Finally, one must consider the computer facilities which have been made available for schools. As a result of several large projects some fairly sophisticated facilities have become available in some areas whereas in other areas schools have had to make

provision for themselves. The most popular methods currently in use include multi-access systems, off-line processing, package material and school computers. With the development of mini and desk top computers it has become easier for schools to acquire such equipment. This has brought with it several problems not least of which is the inflexibility of the equipment. Some emphasis has also been given to the building of computing equipment, but this is no more than a minority interest.

Ways and Means of Achieving Computer Education in Schools.
Session Chairman: Mrs. B. Dutton, H.M.I.

Packages for Schools
Mr. D. R. McLeod, Longslade Upper School, Leicester.

Mr. McLeod is a teacher in a Leicestershire Plan Upper School and has been teaching the NCC package, the ICL/CES 16+ package, and the ICL/CES 16- package. The first two were offered at sixth form level to General Studies courses and the latter was offered as a fourth year option. Later a CSE syllabus was produced based on the ICL/CES 16- package. The NCC package was "Computers and their Impact on Business and Society" which is in two parts. Part one includes

information processing, how a computer works, flow-charting and low level programming, backing store and input/output equipment. Part two is mainly concerned with the implications of computers.
The ICL/CES 16+ scheme includes work on the nature of computers, hardware, the representation of numbers, logic, programming and appreciation of high level languages, systems analysis, social implications and history of computers, and computers in industry. Some students followed courses based on both packages, but differences in philosophy and content meant that only very occasionally was the same point covered twice. Some of the work produced was the generation of poetry, the generation of the internal code of the machine, and curve plotting. Some problems were encountered, arising mainly from the inexperience of the staff, and would probably not have occurred had the members of staff involved been able to attend a course based on the material being taught.

The ICL/CES 16- package aroused the greatest response from the students who were chosen from the higher end of the ability range. They completed the first part of the course in well under the estimated time and were able to use the extra time for work on projects. The syllabus was similar to the ICL/CES 16+ syllabus, and

included programming in CECIL, SIR and BASIC.

All three courses required supplementing with films, books and other material. The school was fortunate with the computing facilities and were able to obtain a rapid turn round from the county computer.

Staffordshire Schools Project
Miss M.J. Homes, North Staffordshire Polytechnic.

The Staffordshire Schools Computer Project was conceived in 1968 at the Staffordshire College of Technology. Since then, the project has been financed and organised by the college which now forms part of the North Staffordshire Polytechnic. The aim of the project was to introduce secondary school pupils to the computer in order that they could understand its attributes and limitations. Initially three school courses were planned for science sixth formers, arts sixth formers and for 13–14 year olds. Numerous courses for teachers are arranged by the college, concentrating mainly on the programming language Alpha code which is used by the schools.

During the first term that a school takes part in the scheme a lecturer from the college travels to the school, and is available to assist the teacher.

At present sixty schools are taking part in the project. About half the students prepare their programs on paper tape and one day a week the computer van takes a transmitting teletype to the school and the tapes are transmitted to Stafford by telephone link and processed at the Computer Centre. The results are transmitted back twenty minutes later. The other schools use mark sense punched cards which have been specially designed for use with the mark sense punch card machine and the language Alphacode. The pupil makes the marks on the card with a soft pencil. The cards are collected one day a week, processed at Stafford and returned with the results the next day.

Indications show that the children on the project have gained a valuable insight into the control and application of computers, and teachers have been able to introduce a variety of topics which might not otherwise have been included during lesson time. The Polytechnic is also providing facilities for the teachers to use the computer on-line to demonstrate educational programs that have been specially written for schools.

Hatfield Polytechnic Schools Project.
Dr. W. Tagg, Hatfield Polytechnic.

Dr. Tagg is the director of the Advisory Unit for Computer Based Education which was set up at Hatfield Polytechnic in September 1971 to encourage and co-ordinate work within the County at school level. Hatfield Polytechnic has been providing computer facilities for schools since 1963. On-line access via terminals in the schools themselves was established in 1968 and in 1970 a DEC system 10 was installed and is now capable of supporting between 50 and 60 simultaneous jobs. About half of the nineteen schools and colleges with on-line terminals have unlimited access into the system, and many other schools use a twice weekly courier service.

As all the educational establishments are using the same computer, it is easy to exchange ideas and teaching material. The Advisory Unit is publishing teaching manuals sometimes written by the teachers themselves and special-purpose software has been written for school use. Some of the schools are offering 'A' level courses in Computer Science or local C.S.E. courses, but most schools are concentrating on non-examination work

with the middle school. The chief motivation for this work is to provide all students with the necessary understanding of computers to enable them to grow up successfully in an increasingly computer orientated society.

In addition to the work done in school there is opportunity for many of the children to visit the Computer Centre where a room is available for them containing 20 on-line terminals. This is especially valuable for those who have previously only had access to the computer via the courier service as they can work for an hour at a terminal under supervision.

The County has set up a number of working parties so that the teachers interested in particular aspects of computer education can be brought together to exchange ideas. Some of the results are a question and answer program on 'O' level History, Science and Economics simulations, a data base analysis / retrieval program for Geographers, and recently work on modern languages.

Kent and Imperial College Schools Scheme.

Mr. A.E. Coulson, Kent Branch, Computer Education.

Mr Coulson was at Dover Grammar School and is now on the staff of the Computing Laboratory, University of Kent. He began by giving some of the history of computing in the Kent schools, which started in 1967 when an Elliot 903 was installed at the Medway and Maidstone College of Technology, and made available to the schools in the county.

Also in 1967 a number of schools became interested in the possibility of using the IBM 7090 at Imperial College. The whole operation depended on the successful use by schools of the simple plastic Porta-Punches for data preparation. An 80-column card was designed and modified so that it could be used in the existing card readers. The cards were sent by post to Imperial College and batched with the normal work of the College.

Today about 150 schools are members of the project which still operates in the same way. Kent has a particular problem in that the population of school children increases by about 9000 each year but despite this each school has the opportunity of participating in this scheme. In many cases where schools are remote from computing centres this scheme is the only possibility

of computer education. Even where schools have other facilities the Imperial College Project offers powerful computing to supplement them by giving access to mathematical and administrative routines on disc, to a magnificent advisory service and the active help of the Schools Liaison Officers.

Scottish Schools Scheme

Mr. W.T. Beveridge, Moray House, Edinburgh

Mr. Beveridge is the Director of the Centre for Computer Education at Moray House College of Education. This is one of six such centres in Scotland set up for schools. All children of 14-15 have courses in computer education which include some programming. They write their programs in school on coding sheets which are then posted to the nearest centre, punched and run. In addition, a school can book a morning or an afternoon to take a class to the centre and use the computers there.

At each centre workshops are run three evenings each week. Two of these are for pupils and one for teachers. There are 40 to 50 schools taking part in this scheme.

Discussion Groups were formed to talk about languages, facilities, and computers in higher education.

Languages.

It was decided that for work in the lower school, for CSE or remedial education, the children must see at least one low and one high level language. The particular language used will depend on the facilities available but the following criteria should be satisfied:

1. It must be suitable for the algorithm.
2. It must be reasonably easy to make programs work.
3. It should assist in showing how the computer works.
4. It must be suitable for non-numerical as well as numerical applications.

Facilities

The facilities should be related to the work. For example, do we wish to teach about computers, enhance Mathematics, program for the sake of programming, or use the computer to teach another subject such as Geography where interaction is essential? It was agreed that rapid turnround is very important. If the work is to obtain Mathematical results then it should be immediate, and in any case it should be regular.

The general feeling was against programmable calculators unless there

were other computing facilities available in conjunction, but it was thought that there is sufficient untapped computing power around the country which could be used by schools. There was discussion on the relative merits of portopunches and mark sense cards, both methods being thought reasonable but neither perfect. It is important to choose hardware carefully for the job it is required to do, not for the prestige value.

Higher Education.

It was thought that computer specialists have adequate courses in general, but more thought should be given to courses for sociologists, economists and others to include some computer science. At the moment higher education courses are very dependent on the reorganisation programmes of schools and the previous experience of their students.

Syllabuses Content and Examinations

Session Chairman : Dr. K. Roberts.

Mr J. D. Tinsley, National Computing Centre Ltd.

Mr. Tinsley is the Head of the Schools Projects at the N.C.C. He began by outlining some of the pamphlets already produced suggesting particular syllabuses. One notable one was produced by the Schools Committee of The British Computer Society in 1969 and revised in 1970 called "Computer Education for All". It is mainly concerned with computer appreciation for children without access to a real machine, and although programming is a part it is not over emphasised. Also included are information processing, the structure and organisation of a digital computer, computers & automation and their social impact, and suggestions for further work.

At present there are two boards offering 'A' level examinations in Computer Science, the Associated Examining Board and the Oxford Local Examining Board. Both syllabuses have been around for some years and both have come in for a certain amount of criticism for being too technical, too vocational, and overlapping with other 'A' level subjects. London University G.C.E. examining board is currently considering an 'A' level in Computing Science which is somewhat different from those

already mentioned but there is no official syllabus as yet. Also under consideration is a syllabus from the Welsh Joint Examination Board, and for some years there has been the London Board Parallel Syllabus for the Royal Liberty School. Within Mathematics a little computing is included in the Mathematics in Education and Industry Project and also in the Schools Mathematics Project.

There is a little 'O' level work done in the special option of Northern Ireland, and mode 3, but most of the computing at this level is contained in the CSE examinations. Practical work and course work are generally unable to carry many marks as some schools would automatically be penalised for lack of equipment.

In Scotland, computing is examined as part of another subject, not in its own right. In the sixth form, however, there are numerical analysis and computing papers, and computer appreciation is taught at pre-examination level.

The main conclusions to be drawn are that syllabuses in computer studies should constantly be reviewed and that a fixed approach to such a dynamic field of interest can only lead to a deterioration in the educational process.

Computers and Academic Disciplines.
Session Chairman: Mr. J. Southall, BCS.

The Computer and Mathematical Disciplines

Mr. D. M. Esterson, Medway and Maidstone College of Technology.

It is argued that computers have not yet led to the development of any new branch of Mathematics, but rather to more intensive investigation of a number of established topics. There is a fundamental similarity between the construction of computer programs and of mathematical proofs. A number of simple problems were examined to illustrate the kind of approach required in computer Mathematics. For example, to sum a series of alternating terms the convergence must be investigated, and a method chosen which will increase the accuracy of the result. Trial and error is now an acceptable method of solving equations with the use of an algorithm. For example $\cos b = b$.

Let $b = 0$

→ Is $\cos b < b$

Yes: finish

No: increase b

Monte Carlo methods can be used in school, also linear programming, numerical methods, models of processes, and statistical methods.

Recurrence relationships take on a new importance, as do continued fractions.

The paper argues that the computer has had a unifying effect on Mathematics, and hopes that the use of computers may enable more people than in the past to come to terms with Mathematical ideas.

Computing and Non-Mathematical Disciplines.
Mr. M.D. Meredith, Southampton University.

Mr. Meredith is from the School of Education, Southampton University, and is involved with both computers and teaching in preservice teacher education and in-service support work. There is a significant trend for well-established non-mathematical disciplines such as Biology and Geography to become more quantitative, making use of statistics and mathematical models.

On the other hand, the computer is being used for library cataloguing, and creative subjects such as Art, English and, of course, Music.

Education is itself, perhaps, a non-mathematical discipline and might be expected to exhibit these same trends. But, for a computer, what cannot be coded does not exist...

Benefits to Industry and Society

Session Chairman: Mr. J. Game, Chief Education Officer, Oxford.

Mr. D. E. Conway, Secretary of Computer Education Group.

One of our most valuable resources today is information which must be reliably processed to avoid the squandering of valuable time, effort and resources by "re-inventing the wheel". To improve information processing we need to develop the potential of computers and increase their fields of application, which implies the development of specialists to develop good software, management to know more about the potential of the computer, and the general public who are both workers and users.

Education needs to be universal so that all these areas are covered. Specialists and managers are relatively few and so easy to educate but the public at large can only be educated at school. The main advantages from education on this massive scale is that the designers and organisers of information systems will have active human elements rather than, as at present, passive ones. Our future rests on this and we must eliminate any fear of the computer. We cannot ban its use so we must make sure it is used sensibly.

Teacher Training

Mr. F. Lovis, Open University

It is important that we plan for several years hence in colleges of education. We should not teach teachers what we want them to teach, as is being done now, but should be more concerned with their education. Computer Science is not important because it enables us to do Statistics in school, or Mathematics, or other subjects, but because of what the computer means to society in enabling us to deal with information.

A teacher must know about state and process. It is insufficient to think that a computer is only a number cruncher, or is only the one machine which is personally available. The concepts are much more important than programming, designing or building computers. It is not necessary to know about the specification of the machine, logic design or electronic circuits but it is necessary to know about the five components and their uses. Also important is problem solving by the use of algorithms and programs, data processing and a little knowledge of systems analysis, history and social implications of computing.

Careers in Computing

Mr. R.G. Stowe, British Timken.

The four main functions of any commercial data processing organisation are

1. Systems Analysis.
2. Programming.
3. Operations of the computer and ancillary equipment.
4. Data preparation.

The systems analyst is the man who investigates the existing systems and methods of the user. He has to either to design new methods or adapt existing ones. He has to be able to communicate with all levels of management and should preferably be a male graduate with some business experience.

The programmer takes the job specifications of the systems analyst and turns them into computer programs. A particular aptitude is required and can be tested by employers. Applicants should have six 'O' Levels and preferably 'A' level.

The operator requires a high degree of concentration and discipline coupled with adequate training. He is in charge of such machinery as a sorter, collator, reproducer, interpreter, and tabulator as well as the operation of the computer. He requires four 'O' levels.

Data preparation is usually done

by women. It is very similar to the job of a typist and speeds of up to 20,000 key depressions per hour can be achieved. The usual requirement is two or three 'O' levels or a favourable aptitude test.

On the technical side there are two possibilities: a technical expert who uses a computer to help his work, or a person with a scientific or technical background who becomes a specialist in the use of a programming language to provide a programming service to technical departments.

Computers in Education

Session Chairman: Mr G.C.T. Bowen, Cheshire County Council.

Educational Administration

Mr. V. Duke, National Council for Educational Technology.

Mr Duke is the Assistant Director of the National Council for Educational Technology, and has made a special study of the value of computers as an educational resource. Much educational administration is concerned with resource allocation, be these resources capital provision, work-space, equipment, materials or teachers time.

Computers can certainly be applied to the solution of management problems in education, & in one way by the

provision of relevant information to individual teachers and lecturers, especially in relation to the availability of teaching and learning materials in the non-book and new media fields. Secondly, in the field of school time-tabling problems the computer has a wide potential, and thirdly in the computer management of the instructional process itself, so that the most effective set of learning activities may be devised to suit individual requirements, and that adequate control of a whole range of individual learners may be accomplished by teachers.

Educational Technology.
Mr. J. R. Hartley, University of Leeds.

Mr Hartley has recently been concerned with the Computer Based Learning Project at the Department of Education, University of Leeds. He has mainly been concerned with Junior Mathematics, English as a second language, the teaching of medical diagnosis, the teaching of applied statistics, and Physical Chemistry at university level.

A feature of the work in practice tasks is that the computer is used to generate material and adjust the task difficulty so that it fits a pupil's competence. The computer also provides feedback when errors are made, and builds

hypotheses from these patterns of error so that remedial teaching can be generated. To undertake such adaptive teaching the computer has to be given models of task difficulty and a framework to represent student performances.

The work in medical diagnosis has the computer generate "patients" given a probability data base which relates symptoms to specific diseases. Students can interrogate these "patients" at the terminal, receive help if necessary, and make a diagnosis.

The work in applied statistics had three objectives: to design and plan the experiment, to carry out the statistics and calculate the result, and to examine the statistical concepts. The use of the computer made the teaching more open ended and was able to eliminate the mundane numerical calculations.

Similarly in the junior mathematics arithmetical drills were designed to generate material to a recipe. Experiments were run to find the models of difficulty so that the pupils could ask for an easier or a more difficult task. These were used to generate remedial loops, number games, practice integrated with teaching, and revision. The schools taking part in this work were asked what they hoped to

achieve by the end of the year, and this work was in fact achieved in one term.

The work described has been carried out using the unit's own Modular One computing system. Twelve terminals, teletypes and audio visual devices, are connected to the computer, eight locally and four using the GPO telephone lines. Some useful experience and material is being built up, but the role of the teacher will be increasingly important if a proper use is to be made of the benefits of computer based learning.

Open Forum.

Questions were answered by Mrs Dutton, Mr Beveridge, Mr Bowen, Mr Conway, Dr. Jackson, Mr Southall, Mr Tinsley.

Question: Should there be more research being done on computer education in schools?

Answers: Several years ago almost anyone was able to obtain the use of a computer, but now one has to put up a very good case as it has been found that facilities available are often not fully used. Several nebulous research projects have been known to be started but no results have been forthcoming. It should be decided whether research is best

done at local or national level. Work is often duplicated because others do not know how much is being done. Research done at university level is of more value if teachers themselves make some contribution to it. The NCC has acted as a clearing house for information on research projects, work being done in schools, the distribution of leaflets, and general communications.

Question: What can be done about the lack of awareness of the value of computers in commercial courses in schools?

Answers: Historically, these courses have been restricted to shorthand and typing, and only recently are economics and other more academic subjects being attempted. This is mainly due to the staff available in schools and rests quite heavily on the colleges of education, although the teachers who have taken commerce courses mainly seem to go into colleges of further education after training. In addition to this, computer education can only be done where there are sufficient teachers who are able to do it.

Question: Why have colleges of education been neglected in the provision of computer facilities?

Answers: All trainee teachers should have

some computer appreciation courses. In Scotland, the colleges of education are the central bodies of computer education, mainly because this was where the work was begun. It may be of more value to the students to use a computer which is already used by schools rather than having one of their own. In this way they can see other work being done. Alternatively, computers should be installed at teachers centres where teachers can use them, and schools can have top priority.

In conclusion, the conference was thought to have been of great value, especially in the opportunity for members to attend discussion groups and meet people with experience in the field. The suggestion that there should be another in two years time was met with full support.

Mildred L. G. Shaw
March 1972.

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