A computer-aided learning package for engineering students: BTEC mathematics at First and National level

A COMPUTER-AIDED LEARNING PACKAGE

FOR

ENGINEERING STUDENTS.

B/TEC MATHEMATICS AT FIRST AND NATIONAL LEVEL.

by

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I would like to thank the Principal of Stamford College and the Lincolnshire Education Authority for the support I have received in producing this Computer-Aided Learning package.Particularly for the unlimited use of computer equipment which included the following:

(i) RM NIMBUS computer and colour monitor.

(ii)Epson dot-matrix printers LX-80 and LQ-800

(iii) Software for word-processing "WRITE" by Oxford CC

Software for screen dumping. "PRNDUMP" by ILEA

Software for program writing. "RMBASIC" by Research Machines Ltd Oxford

I would also like to express my thanks to the students of the B/TEC National Certificate in Engineering Course who took part in the evaluation of the CAL package by answering the questionnaire and making constructive comments.

DECLARATION

I declare that this Computer-Aided Learning package is entirely my own work and is not a copy or a modification of any existing software.

R.E.Ford January 1988.

ABSTRACT

This Computer-Aided Learning package for Mathematics has been written for the use of both teachers and students primarily in further education,although it can equally be used in the secondary education sector. The options I have chosen are topics taken from the mathematics objectives produced by the Business and Technician Education Council, B/TEC, who are responsible for validating many of the courses of a vocational nature offered in colleges of further education.These particular topics are taken from a bank of objectives considered to be relevant to students of engineering.

The educational theory that I have based my work on is that of Skinner and Crowder who pioneered the use of linear and branch programming for the purposes of improving the learning of people of all ages. I have attempted to create an environment in which the student is stimulated to interact with a computer in order to increase his/her awareness of a topic of mathematics. Also through this interaction the student will become computer literate and will lose any apprehension he may have in working with computers.

The computer is now being used in so many situations that soon the vast majority of people will need to be able to interact with them without any fear. Particularly in the various engineering fields, where computers are being used for design,research and development, and for the control of manufacturing processes the engineering student must become aware of their uses.

The Computer-Aided Learning package is being used more and more by the manufacturers of many production and processing systems,to teach the technicians and the operators of the future how to run the systems and also how to diagnose faults

when they arise. By using this package it is my intention that the technicians of the future will become familiar with CAL packages for what ever purpose they are written for.

This CAL package has been produced as an open ended exercise as I intend to continue to add to it as the need arises. The program has been written using RMBASIC incorporating procedures. It will be possible to write a procedure for each additional topic and simply add it on to the end of the existing program.

CONTENTS

SECTION ONE

The Aims of the program in their educational context.

The Business and Technician Education Council,B/TEC,have developed courses for students who wish to obtain vocationally orientated qualifications.The philosophy of B/TEC is to create varied learning situations such as formal classroom teaching,self motivated learning,work experience and so on. We in the Further Education service are being asked to direct our minds to the question of competency based learning.In the consultative document on competency based learning produced by the Further Education Unit in 1984 they made the point that the subjects of science and mathematics, which occupy a central place in the engineering curriculum, are important,but that they are tools of engineering rather than the essence. The measure of a good engineer is that he/she is competent in their performance of various tasks be they motor skills or mental/intellectual skills.

Many of the recent reports are showing that changes are needed in the engineering curricula to keep pace with the changes in the new technologies,which include the uses and applications of microprocessors and computers. It is generally accepted that the quality of education and training of engineers is a key factor upon which national prosperity depends. The Finniston report of 1980,"Engineering our Future" was a catalyst for proposals by the Engineering Council for the future accreditation of engineering courses. And recently the National Council for Vocational Qualifications has been formed to ensure that vocational qualifications not only have a

realistic theoretical content but also that the students receive realistic training in a work placement.

It is essential,because of the changes in technology,to continually consider the curriculum content and the way it is presented to the students. A quote from the report of the Futher Eduction Unit,FEU, states that "the availability of computing facilities from the pocket calculator level upwards has profoundly influenced the futher requirements of engineers for mathematical skills. I see these CAL programs that I have written as one of the means by which my students can learn and reinforce the topics of mathematics that are covered in the formal teaching situation,and will help them to not only improve their mathematical ability but also to become familiar with the use of computers.

The B/TEC courses that are offered in colleges today are not only for the school leaver, but are also for the older person who through the support of the Manpower Services Commission and employers are retraining for different occupations. The older person generally is more apprehensive than the younger person when it comes to using the new technologies. Also some B/TEC students are studying with the Open college and therefore are not able to obtain formal teaching,and must rely on other forms of learning such as the CAL package.

The new courses recently introduced by B/TEC contain a core curriculum which contain the following areas of study.

(i) Communications

(ii) Mathematics

(iii) Engineering science

(iv) Engineering systems

(v) Information Technology and computing

(vi) Engineering materials

(vii) Tools, processes and equipment

(viii)Industry,environment and society.

The intention is that all these various strands of engineering knowledge will be taught for part of the time as integrated studies,thereby making the student aware of the close relationship that exists between the various topics.This software is a means of combining the knowledge of computing and mathematics.It has been written for use by students studying mathematics for B/TEC Certificates and Diplomas in Mechanical,Production and Electronic Engineering. Students without appropriate G.C.E/G.C.S.E passes will embark on a course of study called the First Certificate,if they are studying part-time,and First Diploma if they are studying full-time. Students with the appropriate G.C.E/G.C.S.E passes will study for the National Certificate if they are part-time students,and the National Diploma if they are full-time students.

Mathematics is an essential subject in both First and National programmes of study. Level I work is comparable with G.C.S.E level whilst level II is comparable with Additional mathematics. At level III there are two units of mathematics comparable with Advanced level mathematics. For students who wish to continue their studies at either a University or a Polytechnic there is a double unit of mathematics at level III.

As I have already mentioned some students are studying through an Open learning situation. B/TEC suggest that learning materials may include texts,workbooks,study guides,assignment briefs,case studies,practical kits and COMPUTER SOFTWARE. The materials adopted for any particular purpose will depend upon the learning objectives. Computer software,I believe,though

very time consuming to produce,can be used both to introduce a new topic or to supplement topics already taught to the students.

Programmed instruction made its appearance in Britain in the early 60's. The innovators of programmed learning claimed that the presentation of organised lesson material to the individual student in a pre-arranged sequence,and at a pace determined by the students own responses, can help to overcome some of the deficiencies associated with the classroom teaching techniques. One of the problems is the lack of continuous feedback. One of the main aims of this educational software is to create the situation where there is continuous feedback to the student whilst he is working his way through the various tasks created by the software and the computer.

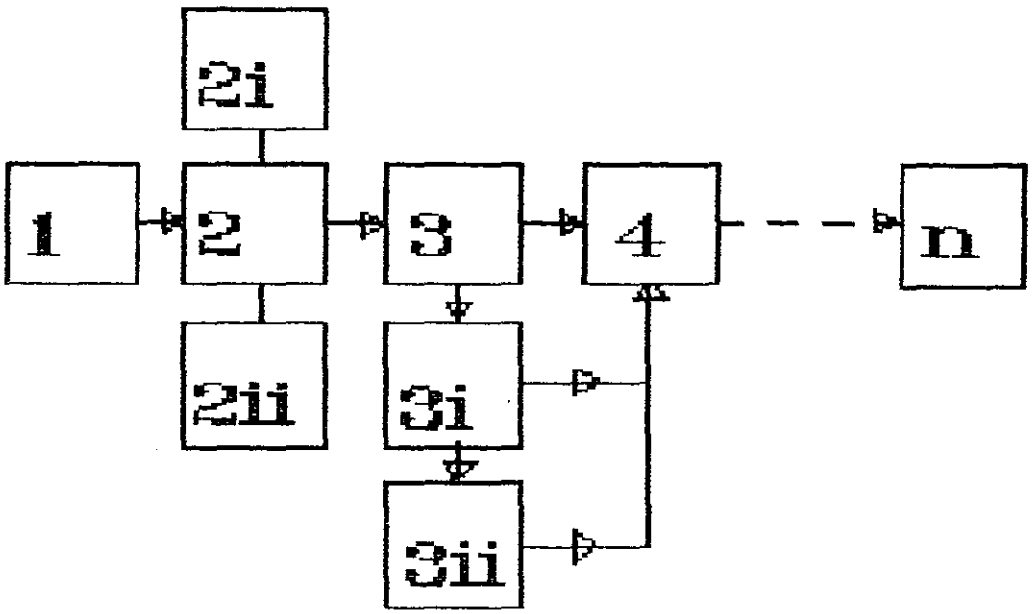
I have based the structure of the programs on the theories of B.F.Skinner and Crowder and their work on linear and branching programmes. It was in 1954 that B.F.Skinner published his article,"The science of learning and the art of teaching". Skinner's reinforcement learning theory was applied to the process of self instruction. His theory was that if a learners actions are followed by rewards they are likely to be repeated and learned. Unreinforced actions on the other hand will disappear from the learners repertoire. Skinner said that "behavioural patterns may,therefore,be shaped at the will of the instructor by use of a series of controlled stimuli".

Crowder who was both a psychologist and statistician suggested modifications to the process of self instruction as advocated by Skinner. Basicly what he did was to introduce alternative sequences into programmes of learning. This is what I have attempted to do in this Computer Aided Learning package. The next instruction on the screen,when running the program,is

dependent upon the previous response. Skinner produced what is known as the Linear-type programme which in effect moved from one point to the next in the line without any opportunity to follow an alternative route if say the respondent made an incorrect response. Crowder on the other hand constructed his programme so that the learners responses could be utilised in the determination of the content and the actual presentation of the material.

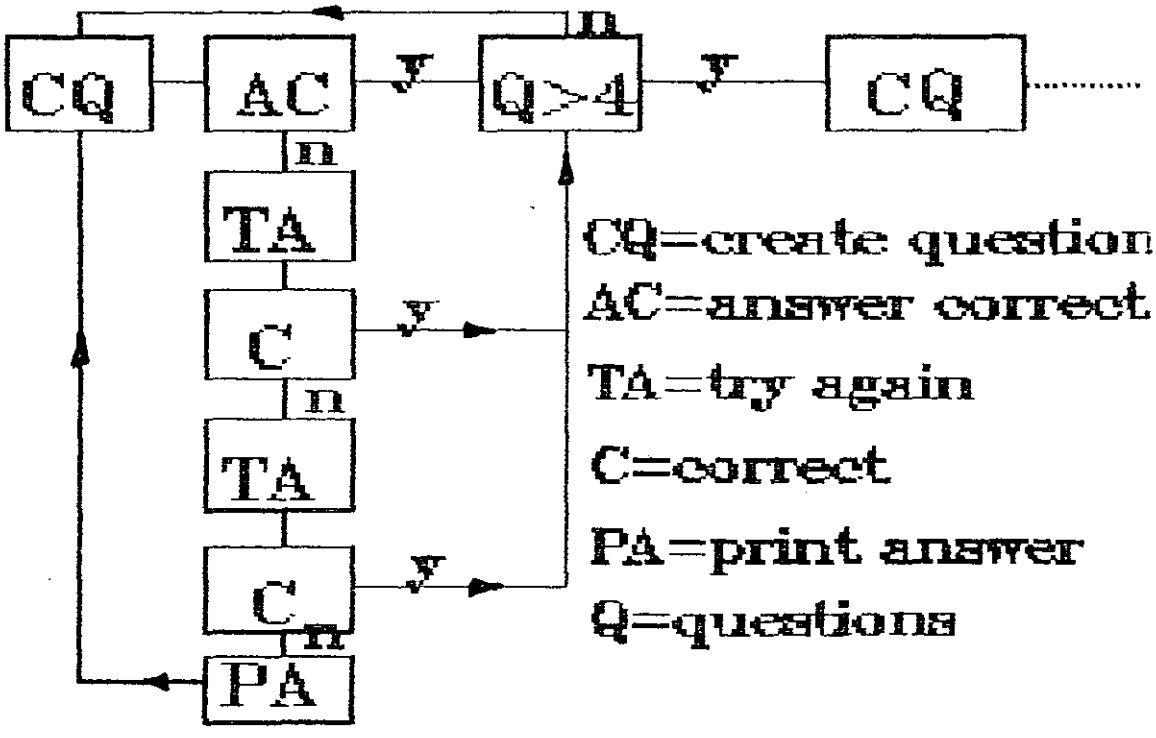
The advocates of programmed learning claim that if a subject can be taught then it can be programmed. According to this claim therefore there are no limits to the areas in which programmed learning can be put to use.

The early forms of programmed learning made use of either books or teaching machines. In the case of books the answer given by the repondent would determine which page to turn to. Similarly with the teaching machine the response would cause a certain frame to appear on the screen. In the design of my program I have created on the screen revision material followed by questions with randomly created parameters. The response from the computer will depend upon whether the students response is correct or not. If it is correct then the next question is created. If it is not correct then the student may have further attempts. If after three attempts the response is still incorrect then the correct method of solution is displayed on the screen and a hard-copy is produced on the printer for further consideration. In fact a hard-copy of all student and computer responses is created as the program is being executed within the computer.



Example of Branching.

Each response will cause a certain procedure to be executed.



SECTION TWO

How the Aims are achieved by the program.

The program is made up of a number of procedures and each procedure contains within it the facility to either create the graphical representation of diagrams or to create questions associated with the diagrams. The diagrams act as a source for refreshing the students awareness of the particular topic of mathematics which he has chosen from the menu presented on the screen. There are four main areas offered on the menu.

(1) Trigonometry

(2) Graphs

(3) 3-Dim Trigonometry

(4) Properties of the Circle

and in one case,Graphs, there is a sub-menu for selecting either problems associated with straight line graphs or quadratic graphs depending upon the group the teacher is working with.

The main aims of the program of learning as I see it is to offer to the student the topic in such a way that he will be able in the future to tackle similar problems with confidence. My intention is to present a topic by creating realistic questions for students of engineering,and to create questions which require looking at the problem in different ways depending upon the data available. As each question is created the student can then respond via the keyboard and his response is analysed by the computer. The correct response is acknowledged by the word "CORRECT" appearing on the screen,whereas an incorrect response is followed by the words"NO,that is not right,TRY AGAIN". This is incorporating the idea of rewarding the student with an encouraging response

if he is correct, or giving him the opportunity of determining the correct answer to the same question. All the time the answer is incorrect the student attempts the same question for a maximum of three tries. If after the third attempt it is still incorrect then a procedure takes over which shows the student,step by step how to obtain the correct answer. The computer then creates a new question of a similar type for the student to attempt. this procedure continues until the student has successfully answered four questions of a similar type,then a different procedure is called up to create further questions on that topic,but with different unknowns.

Also within the program is the facility for obtaining a printout of the students responses whether they are correct or not, and with full model answers if he was unable to input the correct answer after three attempts.This enables him to analyse his responses and this is also a help in reinforcing what he has learnt. When the student runs the program he is asked to input his name,this in turn is printed out so that if he is working on a network with other students all using the same software,he will be able to identify his own printout.

This group of procedures is creating a branching technique which puts up on the screen the appropriate response to the students' response. This is producing a close interaction between the student and the computer. The majority of students seem to respond favourably to this environment.

Many students of engineering will eventually be involved with using the computer as a means of control with CNC machines or engineering processes. Some will be involved with using the computer for design and research. Whatever their jobs are in the future one of the main aims of using CAL packages is to help students become aware of computing facilities.

This CAL package has been written using the RMBASIC high level programming language. A supplimentary function of the package could be to use it to show students of computer programming how the language can be used to create graphics,diagrams and carryout numeric manipulation. The program listing can be analysed to see how the procedures are used to create the total package.

SECTION THREE

Review of similar software produced by a commercial company.

Over the years I have made use of a number of software packages written for the teaching of applied mathematics to engineering students at various levels of study. They have ranged from poor to first-class. Some have been written by "amateur" programmers,like me,but many have been written by the professional programmer employed by a software house. These are generally a much better package since they are produced in bulk and therefore a lot more time and money can be invested in them. Thereby creating a much more sophisticated program than the amateur can produce.

Many of these type of packages are produced as a collaborative scheme between a practising teacher and a professional programmer. This is the ideal situation for producing software,so that the teaching aims can be achieved by the use of the software. The design and production of software to achieve well defined aims is by no means an easy task,as I have discovered whilst being involved with this project.

One piece of software that I have used with mathematics and computer studies students is one that teaches the theory and uses of LOGIC gates and TRUTH tables. This collection of programs,produced by RJE software at £15 consists of,

(i) a program for teaching and testing the knowledge required for producing truth tables for 5 different logic gates. (a) AND gate (b) OR gate (c) NAND gate (d) NOR gate and (e) EXOR gate. Each gate is produced on the screen graphically and the truth table is built up step by step as the two inputs are changed from HIGH voltage (1) to LOW voltage (0) status. There is also the facility for applying inverters to each gate and again truth tables are created for each condition. The rules that

apply to each gate are displayed on the screen, and then gates are displayed and the student has to decide and input the expected output. If the answer is incorrect,the rule is again displayed and the student continues until he gets it right.

(ii) The second program enables students to build up a circuit of logic gates with upto 8 gates per circuit with 4 inputs and 4 outputs to LED's simulated on the screen. Each circuit can have inverters added to any gate and a timing diagram can also be displayed showing the status of each output from each gate and the output at each LED. Example circuits are supplied for use with the second program such as the Full-adder,RS flip-flop and D-type flip-flop switch.

(iii) The third program is a set of multi-choice questions suitable for any introductory computer studies course.

I use this set of programs with students attending the B/TEC National Diploma course in Computer Studies and I have evaluated them against the twelve (12) aspects recommended to the M.Sc in Computer Education group.

(1) Do you think that the program achieves the stated aims?

I consider that the program does in as much as it teaches the students the rules to be applied when selecting gates for a particular logic circuit. The students respond to this program with enthusiasm and it creates a certain amount of competition between two or more students using it.

(2) Does the program provide helpful messages to correct errors? Does it provide ways to help the students understand the program. Is it versatile so the student can control what it does?

The program of truth tables puts up on the screen the rules of logic if the student makes a mistake. It is not

versatile enough for the students to control the total output but the program of logic gates does allow students to design a circuit and control such things as output and the choice of having a timing diagram or not.

(3) Does it provide useful feedback to the user? Does it adapt to the students performance? Does it keep records of the students performance?

It does adapt to student performance but only in as much as it puts on the screen the rules to apply if the student makes a mistake. The feedback is in the form of rules of logic in program 1. In program 2, on logic circuits,once the student has embarked on the layout there is no chance of deleting a gate. The whole circuit has to be started again,which means reloading the program from the beginning. There is no record of the students performance, which is a weakness found in many software packages.

(4) Does the user have to make several different types of input or just key presses?

All the programs are executed by the pressing of just one appropriate key and will only operate if the correct key has been pressed. The changing from HIGH level to LOW level,ie from 1 to 0 is done by pressing either the X or Y keys.

(5) Is any use made of the students own language?

No. There is no opportunity to use standard english. The student is only required to respond by pressing just one key.

(6) What is the approximate time between student inputs?

This is under the control of the student. For the truth table program the inputs are on average every 20 to 30 seconds,but obviously it will depend on how confident the

student feels when answering the questions.

(7) Is the student asked significant or trivial questions?

I did not consider any of the questions in the programs to be trivial as they all seemed important if the student is going to learn the rules of logic.

(8) Using answers for 2 to 7 , do you think the programs encourage an interactive learning environment?

Yes,these programs particularly the first two encourage the student to respond to the questions by pressing the appropriate keys and as I have already said a competitive atmosphere develops as the students progress through the programs.

(9) Does the program/documentation allow the teacher to modify the program in any way?

Programs 2 and 3, that is the logic circuits and the multi-choice programs allow some variation particularly 3 which enables the teacher to put into the program a set of their own questions. Therefore as the course progresses the questions can be changed.

(10) Does the program use graphics. If so are they intrinsically important to the learning process?

Graphics are used and are essential for the first two programs. The programs have built into them facilities for producing on screen the logic gates and the circuits,and these are important to the learning process. The student can see at a glance the effect of any changes that are made to the logic circuit diagram. Without the graphics the programs,particularly the second one would be quite useless.

(11) Does the program use colour/animation, if so are they intrinsically important to the learning process?

Colour is extensively used for indicating the HIGH and LOW status levels. Red for HIGH and Green for LOW. these are very useful particularly in the logic gate program as the status of the inputs are indicated and in the logic circuit program the changes of colour can be slowed down so that the effect of changing the inputs can be seen moving around the circuit.

(12) Does the program use sound?

No. Sound is not used and is not really necessary for these applications.

Generally speaking these programs are professionally produced but the one thing that I have incorporated into my program which these do not have and I have not seen it in other programs,is the hardcopy produced on the printer as the program is run,so that students and the teacher can analyse the responses to the questions created.

SECTION FOUR

How the program is used in an educational situation.

I am making use of this software with a number of students who are attending either full-time or part-time B/TEC courses in Engineering. The software is being used on the network system under MS-DOS operating system. Each student can work independently and at his own speed. This is one of the educational advantages of using CAL packages for teaching purposes. The material can also be used as an assignment for the students. At the beginning of a teaching period I can ask them to work their way through the various options which I can choose,and then I can collect the output from the printer and then allocate a mark for their work.There is no way that they can alter the output from their individual workstations as each response is immediately sent to the spooler and saved ready for output to the printer when the appropriate keys are pressed.

TEACHERS' NOTES FOR USING THE SOFTWARE.

The package has been created for use with students studying for B/TEC mathematics at F and N level. It can also be used with students attending classes for GCSE mathematics. It is proposed that the package is used to suppliment the formal classroom teacher centred learning with sessions of student centred learning at the computer. Each option has been written to occupy a student for approximately 20 minutes,which is considered to be the optimum time that a student will find a session at the computer stimulating.

By using this package you will find that teaching sessions will become more stimulating for both you and your students. As you know,the frequent change of activity helps to

improve the learning and many students enjoy the opportunity of working on a computer. Not only will it help with their learning of mathematics but will also help them to become computer literate.

There are four options for your students to choose from

(1) Trigonometry

(2) Graphs

(i) Straight-line graphs

(ii) Quadratic equation graphs

(3) 3-Dimensional trigonometry

(4) Properties of the circle

You can use them either as a means of supplimenting your teaching of a new topic or they can be used as a means of revision either during a formal teaching session,or students can use them on their own. Comprehensive documentation is supplied with the package.

The facility of obtaining a print-out of all the students responses will enable you to analyse them with your students. You may also wish to use the output as a means of assessment. Once the student has chosen an option he must work through it from beginning to end. The students are not told of the facility for breaking out of the program. If you wish to do so it can be done by pressing the CTL/BREAK keys together.

I hope you find this CAL package a useful addition to your teaching facilities.

EVALUATION OF SOFTWARE.

The software was tested with a class of students who are studying for the B/TEC unit of Mathematics N level which is part of the National Certificate in Engineering. They are studying in the part-time mode. I decided to use this particular group of students as it contained a number of older people who are returning to studying after a break of several years.

Each student was presented with a copy of the documentation and a questionnaire and was asked to work their way through the options at their own pace. They filled in the questionnaire as they worked their way through the options. At the time of the pilot test the group had covered the work on Straight-line graphs and the graphical solution of Quadratic equations, and that week had begun the work on Trigonometry,which was really revision since they should have had basic knowledge of the subject from the previous year,but of course in the case of the older students they had some knowledge but it had been gained a number of years before and were a little "rusty". This was the situation that I had hoped for so that I could get some measure of how useful the software would be for people returning to formal studies.

As the students worked their way through the options I asked them to make comments either in the space provided or to me direct, so that I could take their comments and possibly modify the software in the light of what they said.

One comment that was made by several students was that there was no facility mentioned in the documentation for "breaking out" of the options if they had had enough of the option. I pointed out to them that it was my intention that they did not break-out of the option as this would mean that I

would not be able to get a full measure of their ability when I analysed the print-out with them. If it is necessary to break out of the program this can be done with the CTRL/BREAK keys but this is not made known to the students through the documentation.

Analysis of questionnaires.

Option 1 Trigonometry.

Question 1. 100% had studied the topic before.

Question 2. 80% said that it was at least a year ago since they had studied it.
20% said at least six months since they studied it.

Question 3. 40% said they had found it easy at that time with 60% saying that they had not found it very easy.

Question 4. 80% said they found the graphics quite helpful and 20% found them very helpful.

Question 5. 80% found the documentation quite helpful and 20% found it very helpful.

Question 6. 100% found the method of interaction with the computer easy,i.e. through the keyboard.

Question 7. 100% liked the method of response to their answers.

Question 8. 60% found the output to the printer quite helpful.
40% found it very helpful.

Question 9. The overall reaction from the group was that they had found that working through the option had made the topic

clearer to them.

The responses to the other options were very similar to the responses to option 1.

The overall reaction was favourable and the students said they enjoyed working through the options. Perhaps a measure of their interest was that they were prepared to continue the session beyond their normal finishing time. This was a twilight class running from 5.30 to 7.00. Most of them stayed on to finish the options for another 15 minutes which means there is enough in the package to keep someone busy for nearly two hours. Normally I would use the package by looking at one option only for about 30 minutes. This I think is long enough for a CAL session.

QUESTIONNAIRE

Pilot testing of software.

Course of Study:

Title of software:

Level of study:

Topic:

Tick where appropriate.

Section A

Question (1)

Have you studied this topic before. Yes/No

(If No go to section B)

Question (2)

How long ago was it.

last week/last month/six months/at least one year

Question (3)

Did you find it,

easy/not very easy/difficult/very difficult

Section B

Select the topic of your choice and work through the programme answering questions at the appropriate time.

Question (4)

Do you find the graphics and/or diagrams

very helpful/quite helpful/not very helpful/not at all helpful

Question (5)

Do you find the documentation

very helpful/quite helpful/not very helpful/not at all helpful

Question (6)

Do you find the method of interaction between you and the computer i.e via the keyboard

easy/not very easy/quite difficult/very difficult

Question (7)

Do you like the method of response to your answers

yes/no

Question (8)

Do you find the output to the printer

very helpful/quite helpful/not helpful in analysing your overall response to the questions.

Question (9)

Do you feel that you understand the topic clearer now that you have worked through the software.

It is no clearer/a little clearer/considerably clearer.

SECTION FIVE

DOCUMENTATION

B/TEC MATHEMATICS FOR ENGINEERING STUDENTS

Introduction.

The following programs have been produced to help you understand more fully the mathematics associated with various aspects of engineering. At the end of the topic you have been working through you are able to obtain a hardcopy of your answers and the responses from the computer. With this printout you can then analyse the results either on your own or with your teacher. I hope you find the programs both interesting and stimulating.

NOTE. This software will only run on RESEARCH MACHINES NIMBUS computers running under either MS-DOS or MS-NET operating system.

Instructions.

How to load the programs.

(a) On a standalone system.

(i) Insert the disc into the disc drive.

(ii) Type BASIC and press the ENTER key.

(iii) Type LOADGO "PROJ" and press the ENTER key.

(b) On a Network system.

(i) Type in your identity and password code.

(ii) Your should now see the :N> prompt.

(iii) Type BASIC and press ENTER key.

(iv) Type LOADGO "PROJ" and press the ENTER key.

You will now see the introduction screen, which after a few seconds will change to the screen which gives you some instructions and asks your to input your name. This is so that when your print out your answers on the printer your name will

be printed out at the top of the sheet for easy recognition. When you have input your name you will be presented with the MENU screen which will allow you choose one of 5 options.

(1) Trigonometry.

(2) Graphs.

(3) 3-dimensional trigonometry.

(4) Properties of the circle.

(5) End the session.

Select the number of your choice. Each program has instructions on the screen to guide you to the next stage.

(1) Trigonometry. F Level

You will see before you a right-angled triangle and some of the trigonometrical functions associated with right-angled triangles, i.e. SIN 0, COS 0, TAN 0. Press the space bar to continue. The computer will now randomly generate values and you will be asked to calculate,using an electronic calculator the unknown value. You will be given upto three attempts at the question. If you are correct then the next question will be created. If you are not correct after three attempts then the correct answer will be put up on the screen,and another question created.

After you have successfully answered 4 questions of the same type then further questions will be created associated with different trigonometrical functions. On completion of the set of questions on trigonometry the HELLO screen will appear again. Input your name and then you can output your answers to the printer by pressing CTRL/ALT/PRTSC and continue with another program or bring the session to a close.

(2) Graphs. F Level & N Level.

On selecting the option GRAPHS, you will see that you

INTRODUCTION TO TRIGONOMETRY
THE RIGHT-ANGLED TRIANGLE

SINE A = a/b
COSINE A = c/b
TANGENT A = a/c

SINE C = c/b
COSINE C = a/b
TANGENT C = c/a

From the above it can be seen that
SIN A = COS C
COS A = SIN C

A = 90 - C

Worked example

If a = 34.5 cm and c = 23.6 cm, solve the triangle.

TAN A = a/c
TAN A = 34.5/23.6
TAN A = 1.462
ARCTAN 1.462 = A
A = 55.64 degs
C = 90 - 55.64
C = 34.37 degs
SIN A = a/b
b = a/SIN A
b = 34.5/0.825
b = 41.86 cm

can either work through questions on STRAIGHT-LINE graphs or QUADRATIC equation graphs. Make your choice.

(i) Straight-line graphs.

The computer will generate random integer values for both A and B,the GRADIENT and INTERCEPT respectively. You must decide from the graph the values of A and B and then input them via the keyboard. They can be either positive or negative values. If you are correct then the next line will be generated. If you are not correct then you must try again until you eventually get it right. There is no limit on the number of attempts you can make.

(ii) Quadratic equation graphs.

The computer will create X and Y axes and randomly generate values for A,B and C from which it will draw the curve. You must determine the roots of the equation by reading from the graph. Accuracy is to one decimal place. Five questions will be created for you to answer by reading from the screen direct. A further five questions will be created which you must answer by calculating the roots from the general equation for a Quadratic. You can then input your answer into the computer.

There is no facility in this program for a printout of your responses. At the end of the program the HELLO screen will appear again so that you can either select another program or end the session.

(3) 3-Dimensional Trigonometry. N Level.

This option produces a number of diagrams on the screen which you can look at for as long as you like. You are in control of the rate at which you move from one screen to another. The questions produced are,

(a) Associated with cylindrical prisms.

This is the situation found in the workshop when calculating the angle at which to set the compound vice on the milling machine to create a particular oblique area, and

(b) The measurement of external dovetails.

This gives practice in the mathematics associated with producing dovetails by using a milling machine. You are asked to input your answer to each question.

If correct the next question will appear. Otherwise you will be given three attempts at each question. If still incorrect, the correct answer will appear on the screen before another question is created for you to answer. After you have answered all the cylindrical prism questions then questions associated with external dovetails will be produced. At the end of the option press CTL/ALT/PRTSC keys to printout your responses to the questions so that you can analyse them at your leisure.

(4) Properties of the Circle. F Level.

This option produces a number of diagrams on the screen which you can look at for as long as you like. The control is through the keyboard. After you have looked at the diagrams you will be asked to answer a number of questions. You will be given upto three attempts at each question. If they are all incorrect then the correct answer will be given on the screen,and then another question will be created. Work to at least 2 decimal places of accuracy.

After the option is completed then you can output your results for analysis to the printer by pressing the CTL/ALT/PRTSC keys.

(5) End of the session.

This option will bring the session to a close and will automatically printout the results if they have not already been printed. This ensures that all your printouts are complete and nothing is left stored away in the SPOOLER if you have been working on the network system.

Examples of Hardcopy produced while running the program.

(1) Trigonometry

(3) 3-Dimensional Trigonometry

(4) Properties of the circle

If a = 81 cm and b = 101 cm then calculate angle A.

Input your answer for angle A 53.31
CORRECT

If a = 45 cm and b = 58 cm then calculate angle C.

Input your answer for angle C 39.11
CORRECT

If a = 40 cm and b = 60 cm then calculate angle C.

Input your answer for angle C 5
No! That is not right,try again

Input your answer for angle C 7
No! That is not right,try again

Input your answer for angle C 3
No! That is not right,try again

THIS IS THE CORRECT METHOD OF SOLUTION

ANGLE C =ArcCos(a/b)
ArcCos(40 / 60)= 48.18968 degs

If a = 72 cm and b = 92 cm then calculate angle C.

Input your answer for angle C 38.49
CORRECT

If a = 97 cm and b = 117 cm then calculate angle C.

Input your answer for angle C 33.99
CORRECT

If a = 74 cm and b = 87 cm then calculate angle C.

Input your answer for angle C 6
No! That is not right,try again

fred
3-Dim Trigonometry

EXAMPLE
=======
CYLINDRICAL PRISM
==========

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 71 MM
AND THE ANGLE IS = 32 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER 3
No ! That Is NOT Right, Try Again
INPUT YOUR ANSWER 5
No ! That Is NOT Right, Try Again
INPUT YOUR ANSWER 7
No ! That Is NOT Right, Try Again

THIS IS THE CORRECT METHOD OF SOLUTION

AREA=RADIUS^2*PI/COS ANGLE

71 * 71 * PI/COS 32 = 18674.37 MM2

EXAMPLE
=======
CYLINDRICAL PRISM
==========

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 13 MM
AND THE ANGLE IS = 37 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER 664.79 CORRECT

EXAMPLE
=======
CYLINDRICAL PRISM
==========

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 58 MM
AND THE ANGLE IS = 0 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER 10568.32 CORRECT

EXAMPLE
=======
CYLINDRICAL PRISM
=================

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 96 MM
AND THE ANGLE IS = 36 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER 4
No ! That Is NOT Right, Try Again
INPUT YOUR ANSWER 7
No ! That Is NOT Right, Try Again
INPUT YOUR ANSWER 3
No ! That Is NOT Right, Try Again

THIS IS THE CORRECT METHOD OF SOLUTION

AREA=RADIUS^2*PI/COS ANGLE

96 * 96 * PI/COS 36 = 35787.77 MM2

EXAMPLE
=======
CYLINDRICAL PRISM
=================

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 12 MM
AND THE ANGLE IS = 27 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER 507.72 CORRECT

EXAMPLE
=======
CYLINDRICAL PRISM
=================

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 35 MM
AND THE ANGLE IS = 8 DEGS

THEN CALCULATE THE OBLIQUE AREA

If the radius r = 32 cm then calculate
the area of the circle shown above.

AREA = 4

No! You have made a mistake,try again

AREA = 5

No! You have made a mistake,try again

AREA = 7

No! You have made a mistake,try again

THIS IS THE CORRECT METHOD OF SOLUTION.

AREA = PIxRADIUSxRADIUS

AREA = 3216.991 CM2

If the radius r = 34 cm then calculate
the area of the circle shown above.

AREA = 3631.68

WELL DONE

If the radius r = 12 cm then calculate
the area of the circle shown above.

AREA = 452.38

WELL DONE

If the radius r = 8 cm then calculate
the area of the circle shown above.

AREA = 201.06

WELL DONE

If the radius r = 3 cm then calculate
the area of the circle shown above.

AREA = 28.27

WELL DONE

SECTION SIX

The program listing.

The program was written in the High Level language called BASIC and particularly in the dialect RMBASIC developed by Research Machines Ltd of Oxford. It is a language which is easily learned and the RMBASIC is much more structured than the original dialect of BASIC. This dialect contains a number of advanced facilities including procedures which makes the program more structured. The program can be built up of simple modules to create a comprehensive program.

It also contains facilities for colour and sound,a choice of a 40 column or 80 column mode for screen presentation,and graphics facilities for creating diagrams and graphs. Text can also be created in either graphics or normal print mode thereby giving variations in text style and presentation. Global variables can be used within programs so that a variable can be used in a number of procedures. Also arrays of text and numbers can be handled and sub-routines and functions can be incorporated into procedures.

Graphics and text areas can be specified and upto 9 different areas can be written to in any one program. This makes for a more professional presentation on the screen. I found it a very user-friendly language to work with and it was quite adequate for this project. The program requires 60KBytes of memory.

Explaination of Program Listing.

Lines 10 - 300 These create the initial logo on the screen.

Line 310 Clears the graphics from memory.

Lines 320 - 470 These create the "HELLO" screen and waits for the inputting of the students name.

Line 480 Receives name.

Lines 490 - 670 Creates "MENU" screen.

Lines 690 - 740 Options are selected and according to which option is chosen appropriate procedures are executed.

Lines 750 - 820 These lines are executed if option 5, "end the session" has been chosen.

Lines (830 - 4270) Procedure named TRIG. This procedure starts by giving instructions for answering the

830 - 1020 questions created further on in the procedure.

1030 - 1300 This block of coding creates drawing 1.(see screen printouts in documentation section.)

1310 - 1650 This block of coding creates drawing 2.

1660 - 1950 This block of coding creates drawing 3.

1960 - 2120 This creates the rectangular prism.

2130 Start of the first calculations.

2390 Awaits answer.

2400 Prints out answer to printer.

2410 Calculates true value.

2420 Compares values.

2470 Keeps the total number of attempts at question.

2510 Keeps a count of the number of questions created of a given type.

2540 - 2610 Sub-routine to print correct answer on the screen.

2620 - 3060 Creates different type of question associated

with oblique areas.

3070 - 3460 Creates third type of question involved with oblique areas.

3470 - 3820 Creates drawing of external dovetail on the screen.

3830 - 4270 Creates questions and if necessary the sub-routine is executed in order to give the correct answer.

Lines (4280 - 5160) Procedure for GRAPHS option.

4320 - 4360 Creates introduction panel to GRAPHS option.

4370 - 4440 GRAPHS menu screen.

4470 Choose GRAPHS options from menu.

4480 Choice of procedures to draw axes for graphs.

4500 Executes AXES procedure.

4510 - 5150 Creates questions of GRADIENT and INTERCEPT.

Lines 5170 - 5450 AXES procedure defined.

5470 Executes AXES2 procedure for Quadratic equation option.

5480 Executes TEXT procedure. 2

5490 - 5660 Creates values of A,B and C for $AX + BX + C$

5670 - 5890 Creates further questions about quadratic equations.

Lines (5900 - 7030) Main procedure for creating diagrams for Properties of a Circle option.

5940 - 6000 Introduction screen.

6010 - 6270 Creates first diagram.

6280 - 6500 Creates second diagram.

6510 - 6740 Creates third diagram.

6750 - 6970 Creates fourth diagram.

6980 - 7020 Executes procedures named ROUND1 to ROUND5. Each procedure creates questions and prints the

correct answer if necessary by calling up a sub-routine.

Lines 7040 - 7470 Procedure named ROUND1 defined.

7480 - 7910 .. .. ROUND2 ..

7920 - 8430 .. .. ROUND3 ..

8440 - 8940 .. .. ROUND4 ..

8950 - 9410 .. .. ROUND5 ..

Each procedure has a built-in sub-routine for printing on the screen and the printer the correct answer if necessary.

9420 - 9730 Procedure AXES2 defined.

9740 - 9790 Procedure TEXT defined.

9800 - 9840 Procedure TEXT1 defined. Used for variation in Quadratic equation questions.

Lines (9850 - 10380) Procedure TRIG1 defined. This creates the diagrams and trigonometrical functions associated with a right-angled triangle.

10320 - 10380 Executes in turn the procedures,ALPHA,BETA, GAMMA,ALPHA1,EPSILON and PHI. Each procedure creates questions and puts up on the screen the responses of the student and also prints out the correct answer if required.

10390 - 10830 Procedure ALPHA defined.

10840 - 11270 .. BETA ..

11280 - 11710 .. GAMMA ..

11720 - 12150 .. ALPHA1 ..

12160 - 12590 .. EPSILON ..

12600 - 13040 .. PHI ..

The student is required to answer the questions created by using an electronic calculator. The combined use of calculator and computer is

required throughout the question and answer session for most of the options chosen. Each procedure has built-in subroutines to printout the correct answers before moving on to the next question.

13050 - 13120 Procedure TRIANGLE defined. This creates a right-angled triangle at the top of the screen for students to refer to when answering questions.

```
 10 REM *M.SC PROJECT COMP ED*
 20 CLS : HOME
 30 SET MODE 40
 40 GLOBAL Fred$
 50 REM * CREATE LOGO *
 60 SET PAPER 1 : SET BORDER 1 : CLS
 70 FOR I := 1 TO 100 STEP 10
 80   SET BRUSH I / 10
 90   AREA 5 + I, 200 - I; 105 + I, 200 - I; 105 + I, 100 - I; 5 + I, 100 - I; 5 + I, 200 - I
100 NEXT I
110 SET BRUSH 0
120 CIRCLE 20, 145, 60
130 SET BRUSH 15 : CIRCLE 17, 145, 60
140 SET BRUSH 8 : CIRCLE 15, 145, 60
150 SET BRUSH 1 : AREA 190, 80; 190, 85; 196, 85; 196, 80
160 SET BRUSH 0 : CIRCLE 2, 145, 32; 145, 15; 170, 60; : AREA 143, 32; 147, 32; 147, 15; 143, 15
170 SET BRUSH 15 : AREA 105, 105; 145, 105; 145, 85; 105, 85
180 SET BRUSH 2 : PLOT "CAMET", 106, 90
190 SET BRUSH 15 : PLOT "LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY", 10, 240
200 PLOT "M.Sc. COMPUTER EDUCATION", 60, 230
210 PLOT "(C) R.E.FORD", 100, 220
220 PLOT "CENTRE FOR ADVANCEMENT OF MATHEMATICAL", 10, 210
230 PLOT "EDUCATION IN TECHNOLOGY", 60, 200
240 SET BRUSH 4 : PLOT "B/TEC MATHEMATICS", 160, 180
250 PLOT "F & H LEVEL ", 200, 170
260 PLOT "FOR ENGINEERING", 180, 160
270 PLOT "STUDENTS", 220, 150
280 SET BRUSH 5 : PLOT "A COMPUTER-AIDED", 180, 130
290 PLOT "LEARNING PACKAGE", 180, 120
```

```
300 FOR I := 1 TO 5000 : NEXT I
310 CLG
320 SET MODE 80
330 SET PAPER 3 : SET BORDER 1 : SET PEN 0 : CLS
340 SET BRUSH 2 : AREA 5, 5; 5, 244; 634, 244; 634, 5 STYLE 3
350 AREA 7, 7; 7, 242; 632, 242; 632, 7 STYLE 3
360 PLOT "Hello,", 20, 220 SIZE 2
370 PLOT "welcome to a mathematics revision session.You will be asked to select", 50, 210
380 PLOT "the topic of mathematics that you would like to revise,and as you work your", 15, 200
390 PLOT "way through the exercises an output to the printer will be created. If you", 15, 190
400 PLOT "are working on a NIMBUS NETWORK system then at the end of your session press", 15, 180
410 SET BRUSH 1 : PLOT "ctrl/alt/prtsc", 15, 170 : SET BRUSH 2
420 PLOT "keys simultaneously so that you can obtain your own individual", 130, 170
430 PLOT "printout with your name on it for easy recognition.Please tell me your name", 15, 160
440 PLOT "and I hope you find the revision session stimulating.Go for it!", 15, 150
450 SET WRITING 1 TO 5, 11; 75, 22
460 SET BRUSH 1 : PLOT "What is your name", 80, 47 SIZE 2
470 SET WRITING 1 : SET CURPOS 50, 20
480 SET WRITING 1 : INPUT Fred$
490 SET MODE 40
500 SET PAPER 1 : CLS : SET BORDER 8
510 AREA 5, 5; 5, 235; 315, 235; 315, 5
520 SET BRUSH 8 : AREA 6, 6; 6, 234; 314, 234; 314, 6
530 FOR I := 2 TO 200 STEP 40
540   SET BRUSH 15 : AREA 11, 9 + I; 11, 19 + I; 31, 19 + I; 31, 9 + I
550   SET BRUSH 4 : AREA 10, 10 + I; 10, 20 + I; 30, 20 + I; 30, 10 + I
560 NEXT I
570 PLOT "MENU", 145, 220
580 PLOT "ENGINEERING MATHEMATICS", 70, 210
```

```
590 SET BRUSH 14 : PLOT "1  TRIGONOMETRY", 18, 172 : PLOT "F   LEVEL", 200, 172

600 PLOT "2  GRAPHS", 18, 132 : PLOT "F&N  LEVEL", 200, 132

610 PLOT "3  3 DIMENSIONAL", 18, 92 : PLOT "F&N  LEVEL", 200, 92

620 PLOT "TRIGONOMETRY", 50, 82

630 PLOT "4  PROPERTIES OF", 18, 52 : PLOT "F   LEVEL", 200, 52

640 PLOT "THE CIRCLE", 50, 42

650 PLOT "5  END SESSION", 18, 12

660 SET BRUSH 2 : PLOT "SELECT THE NUMBER", 170, 30

670 PLOT "OF YOUR CHOICE", 185, 20

680 SET CURSOR 0

690 Answer$ := GET$()

700 IF Answer$ = "1" THEN Trig1 : CLG : GOTO 310

710 IF Answer$ = "2" THEN Graph : CLG : SET MODE 40 : GOTO 310

720 IF Answer$ = "3" THEN Trig : CLG : GOTO 310

730 IF Answer$ = "4" THEN Round : CLG : GOTO 310

740 IF Answer$ = "5" THEN CLS : SET BRUSH 15 : PLOT "END OF SESSION", 105, 150

750 PRINT #2 ! ! !, TAB (10) "END OF SESSION"

760 PLOT "DO NOT FORGET YOUR PRINTOUT", 50, 140

770 PLOT "I hope you have found the session useful", 1, 130

780 SET BRUSH 14 : PLOT "GOODBYE", 100, 100 SIZE 2

790 FOR I := 1 TO 5000 : NEXT I

800 PRINT #2 ! ! ! !, "GOODBYE", Fred$

810 REM BYE

820 IF Answer$ > "5" OR Answer$ < "1" THEN 570

830 PROCEDURE Trig

840   GLOBAL Fred$

850   PRINT #2, Fred$

860   PRINT #2, "3-Dim Trigonometry"

870   CLG : SET BRUSH 0 : AREA 35, 95; 25, 105; 25, 185; 35, 195; 295, 195; 305, 185; 305, 105; 295, 95
```

```
880  SET BRUSH 15 : AREA 30, 100; 20, 110; 20, 190; 30, 200; 290, 200; 300, 190; 300, 110; 290, 100
890  SET BRUSH 11 : PLOT "3-DIMENSIONAL", 55, 170 SIZE 2
900  PLOT "TRIGONOMETRY", 60, 150 SIZE 2
910  SET BRUSH 6 : PLOT "F & N LEVEL", 70, 110 SIZE 2
920  FOR I := 1 TO 2000 : NEXT I
930  CLG : SET BRUSH 4 : AREA 0, 249; 319, 249; 319, 176; 0, 176
940  SET BRUSH 1 : AREA 5, 245; 314, 245; 314, 180; 5, 180
950  SET BRUSH 15 : PLOT "This set of  exercises is to help you", 7, 235
960  PLOT " understand  some  applications  of", 7, 225
970  PLOT "ENGINEERING TRIGONOMETRY.The computer", 7, 215
980  PLOT "will  create  questions  for  you  to ", 7, 205
990  PLOT "answer.You  will  need  a  CALCULATOR.", 7, 195
1000 PLOT "The diagrams are for revision purposes.", 7, 185
1010 SET CURSOR 0 : SET CURPOS 10, 20 : PRINT "PRESS ANY KEY TO CONTINUE"
1020 Answer$ := GET$() : CLG
1030 REM * DRAW FIGURE 1 *
1040 SET BRUSH 10
1050 AREA 20, 50; 150, 150; 300, 150; 170, 50
1060 SET BRUSH 2
1070 LINE 70, 70; 170, 245
1080 SET BRUSH 15 : LINE 170, 240; 170, 100; 70, 70 STYLE 3
1090 PLOT "O", 85, 80
1100 PLOT "A", 175, 235
1110 PLOT "B", 175, 100
1120 PLOT "C", 60, 60
1130 LINE 150, 95; 150, 120; 170, 126
1140 PLOT "D", 140, 150
1150 PLOT "E", 305, 150
1160 PLOT "F", 175, 40
```

```
1170  PLOT "G", 10, 40
1180  PLOT "POINT A IS ", 185, 225
1190  PLOT "PROJECTED DOWN", 185, 215
1200  PLOT "TO POINT B ON", 185, 205
1210  PLOT "PLANE DEFG", 185, 195
1220  SET BRUSH 2 : PLOT "PLANE DEFG", 185, 125
1230  AREA 5, 240; 140, 240; 140, 200; 5, 200
1240  SET BRUSH 15
1250  PLOT "THE ANGLE BETWEEN", 5, 225
1260  PLOT "LINE AC AND PLANE", 5, 215
1270  PLOT "DEFG IS 0", 35, 205
1280  SET CURPOS 10, 23 : PRINT "PRESS ANY KEY TO CONTINUE"
1290  Answer$ := GET$()
1300  CLS
1310  REM * DRAW FIGURE 2 *
1320  SET BRUSH 8
1330  AREA 50, 50; 50, 125; 200, 200; 200, 125
1340  SET BRUSH 7
1350  AREA 50, 50; 50, 125; 200, 90; 200, 15
1360  SET BRUSH 2
1370  LINE 200, 163; 50, 87; 200, 53 STYLE 5
1380  PLOT "A", 205, 90
1390  PLOT "B", 205, 5
1400  PLOT "C", 40, 45
1410  PLOT "D", 40, 125
1420  PLOT "E", 205, 200
1430  PLOT "F", 205, 115
1440  SET BRUSH 14
1450  PLOT "I", 40, 85
```

```
1460  PLOT "H", 205, 158
1470  PLOT "J", 205, 48
1480  PLOT "O", 65, 83
1490  AREA 5, 240; 150, 240; 150, 210; 5, 210
1500  SET BRUSH 2
1510  PLOT "THE ANGLE BETWEEN", 10, 230
1520  PLOT "TWO INTERSECTING", 10, 220
1530  PLOT "       PLANES", 10, 210
1540  SET BRUSH 3
1550  PLOT "PLANE ABCD", 120, 40
1560  PLOT "PLANE CDEF", 120, 150
1570  AREA 220, 220; 319, 220; 319, 150; 220, 150
1580  SET BRUSH 14
1590  PLOT "THE ANGLE", 225, 205
1600  PLOT "BETWEEN THE", 225, 195
1610  PLOT "TWO PLANES", 225, 185
1620  PLOT "IS ANGLE HIJ", 225, 175
1630  PLOT "SHOWN AS O", 225, 165
1640  SET CURPOS 28, 21 : PRINT "PRESS ANY KEY" : SET CURPOS 28, 22 : PRINT " TO CONTINUE"
1650  Answer$ := GET$() : CLG
1660  REM THIRD FIGURE
1670  AREA 5, 230; 100, 230; 100, 180; 5, 180
1680  SET BRUSH 6
1690  PLOT "LENGTHS AND", 9, 220
1700  PLOT "AREAS ON AN", 9, 207 : PLOT "INCLINED", 20, 194 : PLOT "PLANE", 30, 181
1710  SET BRUSH 2 : AREA 220, 220; 310, 220; 310, 120; 220, 120
1720  SET BRUSH 7 : PLOT "DE", 289, 200 : PLOT "COS O = --", 225, 190 : PLOT "DC", 289, 180
1730  PLOT "ABCD=----", 225, 150 : PLOT "AFED", 265, 160; : PLOT "COS O", 265, 140
1740  SET BRUSH 3 : AREA 50, 100; 150, 200; 200, 150; 100, 50; 50, 100
```

```
1750  SET BRUSH 4
1760  AREA 100, 50; 200, 150; 200, 100
1770  SET BRUSH 7
1780  LINE 50, 100; 150, 150; 150, 200 STYLE 3
1790  LINE 150, 150; 200, 100 STYLE 3
1800  PLOT "A", 40, 90
1810  PLOT "B", 150, 205
1820  PLOT "C", 205, 150
1830  PLOT "D", 97, 35
1840  PLOT "E", 200, 85
1850  PLOT "F", 156, 150
1860  PLOT "O", 130, 70
1870  SET BRUSH 4
1880  AREA 150, 10; 300, 60; 300, 10
1890  SET BRUSH 7
1900  PLOT "D", 140, 5
1910  PLOT "C", 302, 62
1920  PLOT "E", 305, 5
1930  PLOT "O", 180, 8
1940  SET CURPOS 2, 23 : PRINT "PRESS ANY KEY" : SET CURPOS 2, 24 : PRINT " TO CONTINUE "
1950  Answer$ := GET$() : CLG
1960  REM INSTRUCTIONS FOR CALCULATIONS
1970  SET PAPER 1 : SET BRUSH 9 : CLS : AREA 5, 245; 314, 245; 314, 170; 5, 170
1980  SET BRUSH 15 : PLOT "THE OBLIQUE AREA OF A PRISM", 45, 230
1990  PLOT "OBLIQUE AREA =  ----------------", 20, 190 : SET BRUSH 2 : PLOT "CROSS-SECTIONAL AREA", 150, 20
2000  PLOT "COS O", 200, 180
2010  SET BRUSH 14 : AREA 5, 165; 314, 165; 314, 5; 5, 5
2020  SET BRUSH 0 : LINE 10, 150; 260, 150; 260, 100; 10, 100; 10, 150
2030  SET BRUSH 2 : AREA 260, 150; 285, 130; 285, 80; 260, 100
```

```
2040  SET BRUSH 0 : LINE 285, 80; 35, 80; 10, 100 : LINE 100, 100; 100, 150
2050  LINE 260, 130; 35, 130; 10, 150 STYLE 3 : LINE 35, 130; 35, 80 STYLE 3
2060  SET BRUSH 2 : AREA 100, 100; 150, 150; 175, 130; 125, 80
2070  PLOT "0", 103, 110
2080  SET BRUSH 0 : LINE 125, 90; 125, 60 : LINE 270, 95; 270, 60
2090  PLOT "OBLIQUE AREA.", 70, 45
2100  PLOT "CROSS-SECT AREA.", 190, 45
2110  SET CURPOS 2, 23 : PRINT "PRESS ANY KEY TO CONTINUE"
2120  Answer$ := GET$() : CLG
2130  REM START FIRST SET OF CALCULATIONS
2140  Total := 0 : Count := 0
2150  Radius := INT(RND(1) * 90) + 10
2160  Angle := INT(RND(1) * 45)
2170  CLS : HOME
2180  SET PAPER 14 : SET RAD TRUE
2190  CLS
2200  SET PEN 2
2210  PRINT TAB (15) "EXAMPLE"
2220  PRINT #2, ! ! TAB (15) "EXAMPLE"
2230  PRINT TAB (15) "======="
2240  PRINT #2, TAB (15) "======="
2250  PRINT TAB (11) "CYLINDRICAL PRISM"
2260  PRINT #2, TAB (11) "CYLINDRICAL PRISM"
2270  PRINT TAB (11) "================="
2280  PRINT #2, TAB (11) "================="
2290  PRINT ! TAB (5) "OBLIQUE AREA = PI*RADxRAD/COS A"
2300  PRINT #2, ! TAB (5) "OBLIQUE AREA = PI*RADxRAD/COS A"
2310  PRINT ! TAB (5) "IF THE RADIUS IS = "; Radius; "MM"
2320  PRINT #2, ! TAB (5) "IF THE RADIUS IS = "; Radius; "MM"
```

```
2330  PRINT TAB (5) "AND THE ANGLE IS = "; Angle; "DEGS"
2340  PRINT #2, TAB (5) "AND THE ANGLE IS = "; Angle; "DEGS"
2350  PRINT ! TAB (3) "THEN CALCULATE THE OBLIQUE AREA"
2360  PRINT #2, ! TAB (3) "THEN CALCULATE THE OBLIQUE AREA"
2370  PRINT ! ! !
2380  PRINT #2, ! ! !
2390  PRINT TAB (5) "INPUT YOUR ANSWER  "; : INPUT Oblique Area
2400  PRINT #2, TAB (5) "INPUT YOUR ANSWER  "; : PRINT #2, Oblique Area,
2410  True Area := PI * Rad * Rad / COS(Angle * PI / 180)
2420  IF ABS(True Area - Oblique Area) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 2450
2430  IF ABS(True Area - Oblique Area) <  1e-02 THEN PRINT #2, "CORRECT"
2440  FOR I := 1 TO 2000 : NEXT I : IF ABS(True Area - Oblique Area) <  1e-02 THEN 2510
2450  PRINT TAB (2) " No ! That Is NOT Right, Try Again "
2460  PRINT #2, TAB (2) " No ! That Is NOT Right, Try Again "
2470  Total := Total + 1
2480  IF Total < 3 THEN 2390
2490  GOSUB 2540
2500  GOTO 2130
2510  Count := Count + 1
2520  IF Count < 4 THEN 2150
2530  GOTO 2620
2540  PRINT ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
2550  PRINT #2, ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
2560  PRINT ! TAB (7) "AREA=RAD*RAD*PI/COS ANGLE"
2570  PRINT #2, ! TAB (7) "AREA=RAD*RAD*PI/COS ANGLE"
2580  PRINT ! TAB (2) Radius; "*"; Radius; "* PI/COS"; Angle; "="; True Area; "MM2"
2590  PRINT #2, ! TAB (2) Radius; "*"; Radius; "* PI/COS"; Angle; "="; True Area; "MM2"
2600  FOR I := 1 TO 5000 : NEXT I
2610  RETURN
```

```
2620  Total := 0 : Count := 0 : REM START SECOND CALCULATIONS.
2630  Radius := INT(RND(10) + 8)
2640  Oblique Area := INT(RND(100) + 1100)
2650  CLS : HOME
2660  PRINT TAB (15); "EXAMPLE"
2670  PRINT #2, ! ! TAB (15); "EXAMPLE"
2680  PRINT TAB (15) "======="
2690  PRINT #2, TAB (15) "======="
2700  PRINT TAB (11) "CYLINDRICAL PRISM"
2710  PRINT #2, TAB (11) "CYLINDRICAL PRISM"
2720  PRINT TAB (11) "=================="
2730  PRINT #2, TAB (11) "=================="
2740  PRINT TAB (5) "ANGLE A=ARCCOS(R*R*PI/OBLIQUE AREA)"
2750  PRINT #2, TAB (5) "ANGLE A=ARCCOS(R*R*PI/OBLIQUE AREA)"
2760  PRINT ! TAB (7) "IF THE RADIUS IS = "; Radius; "MM"
2770  PRINT #2, ! TAB (7) "IF THE RADIUS IS = "; Radius; "MM"
2780  PRINT ! TAB (7) "AND THE OBLIQUE AREA="; Oblique Area; "MM2"
2790  PRINT #2, ! TAB (7) "AND THE OBLIQUE AREA="; Oblique Area; "MM2"
2800  PRINT ! TAB (5) "CALCULATE THE OBLIQUE ANGLE"
2810  PRINT #2, ! TAB (5) "CALCULATE THE OBLIQUE ANGLE"
2820  PRINT ! TAB (10) "INPUT YOUR ANSWER"; : INPUT A
2830  PRINT #2, ! TAB (10) "INPUT YOUR ANSWER"; : PRINT #2, A,
2840  Y := PI * Radius * Radius / Oblique Area
2850  Oba := (- ATN(Y / SQRT(- Y * Y + 1)) + PI / 2) * 180 / PI
2860  IF ABS(Oba - A) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 2900
2870  IF ABS(Oba - A) <  1e-02 THEN PRINT #2, "CORRECT"
2880  FOR I := 1 TO 2000 : NEXT I
2890  IF ABS(Oba - A) <  1e-02 THEN 2960
2900  PRINT TAB (5) "NO!That is not right,try again"
```

```
2910  PRINT #2, TAB (5) "NO!That is not right,try again"
2920  Total := Total + 1
2930  IF Total < 3 THEN 2820
2940  GOSUB 2990
2950  GOTO 2620
2960  Count := Count + 1
2970  IF Count < 4 THEN 2630
2980  GOTO 3070
2990  PRINT ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
3000  PRINT #2, ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
3010  PRINT ! "ARCCOS(R*R*PI/OBLIQUE AREA)=ANGLE A"
3020  PRINT #2, ! "ARCCOS(R*R*PI/OBLIQUE AREA)=ANGLE A"
3030  PRINT ! "ARCCOS("; Radius; "*"; Radius; "*PI/"; Oblique Area; ")="; Oba; "DEG"
3040  PRINT #2, ! "ARCCOS("; Radius; "*"; Radius; "*PI/"; Oblique Area; ")="; Oba; "DEG"
3050  FOR I := 1 TO 5000 : NEXT I
3060  RETURN
3070  Total := 0 : Count := 0 : REM START THIRD CALCULATIONS.
3080  Angle := INT(RND(45))
3090  Oblique Area := INT(RND(100) + 1100)
3100  CLS : HOME
3110  PRINT TAB (15) "EXAMPLE"
3120  PRINT #2, ! ! TAB (15) "EXAMPLE"
3130  PRINT TAB (15) "======="
3140  PRINT #2, TAB (15) "======="
3150  PRINT ! TAB (4) "RADIUS=SQR(OBLIQUE AREA*COS A/PI)"
3160  PRINT #2, ! TAB (4) "RADIUS=SQR(OBLIQUE AREA*COS A/PI)"
3170  PRINT ! TAB (5) "IF THE OBLIQUE ANGLE="; Angle; "DEG"
3180  PRINT #2, ! TAB (5) "IF THE OBLIQUE ANGLE="; Angle; "DEG"
3190  PRINT ! TAB (5) "AND THE OBLIQUE AREA="; Oblique Area; "MM2"
```

```
3200  PRINT #2, ! TAB (5) "AND THE OBLIQUE AREA="; Oblique Area; "MM2"
3210  PRINT ! TAB (5) "THEN CALCULATE THE RADIUS"
3220  PRINT #2, ! TAB (5) "THEN CALCULATE THE RADIUS"
3230  PRINT ! ! TAB (10) "INPUT YOUR ANSWER"; : INPUT Radius
3240  PRINT #2, ! ! TAB (10) "INPUT YOUR ANSWER"; : PRINT #2, Radius,
3250  R0 := SQRT(Oblique Area * COS(Angle * PI / 180) / PI)
3260  IF ABS(R0 - Radius) < 1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 3300
3270  IF ABS(R0 - Radius) < 1e-02 THEN PRINT #2, "CORRECT"
3280  FOR I := 1 TO 2000 : NEXT I
3290  IF ABS(R0 - Radius) < 1e-02 THEN 3360
3300  PRINT TAB (5) "NO!That is not right,try again"
3310  PRINT #2, TAB (5) "NO!That is not right,try again"
3320  Total := Total + 1
3330  IF Total < 3 THEN 3230
3340  GOSUB 3390
3350  GOTO 3070
3360  Count := Count + 1
3370  IF Count < 4 THEN 3080
3380  GOTO 3470
3390  PRINT ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
3400  PRINT #2, ! ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
3410  PRINT TAB (2) "RADIUS=SQR(OBLIQUE AREA*COS A/PI)"
3420  PRINT #2, TAB (2) "RADIUS=SQR(OBLIQUE AREA*COS A/PI)"
3430  PRINT "SQR("; Oblique Area; "*COS "; Angle; "/PI)="; R0
3440  PRINT #2, "SQR("; Oblique Area; "*COS "; Angle; "/PI)="; R0
3450  FOR I := 1 TO 5000 : NEXT I
3460  RETURN
3470  REM MEASUREMENT OF EXT DOVETAIL
3480  REM DRAW DIAGRAM OF DOVE TAIL
3490  SET BORDER 10 : SET PAPER 10 : CLS
```

```
3500  SET BRUSH 15 : AREA 5, 245; 314, 245; 314, 220; 5, 220
3510  SET BRUSH 2 : PLOT "MEASUREMENT OF EXTERNAL DOVETAIL", 30, 232
3520  PLOT "BY THE USE OF PRECISION ROLLERS.", 30, 222
3530  AREA 50, 85; 50, 110; 130, 110; 90, 160; 210, 160; 170, 110; 250, 110; 250, 85; 50, 85
3540  SET BRUSH 8 : FLOOD 140, 125
3550  SET BRUSH 7 : CIRCLE 20, 88, 130; 212, 130
3560  SET BRUSH 0 : LINE 68, 137; 68, 185 : LINE 232, 137; 232, 185
3570  LINE 68, 180; 232, 180
3580  AREA 68, 180; 74, 182; 74, 178 : AREA 232, 180; 226, 182; 226, 178
3590  PLOT "M", 147, 182 : LINE 88, 130; 130, 110; 88, 110; 88, 130
3600  LINE 212, 130; 170, 110; 212, 110; 212, 130
3610  LINE 130, 107; 130, 70
3620  LINE 170, 107; 170, 70
3630  LINE 130, 73; 170, 73
3640  AREA 130, 73; 136, 75; 136, 71
3650  AREA 170, 73; 164, 75; 164, 71
3660  PLOT "REF", 140, 74
3670  PLOT "d dia", 20, 130
3680  LINE 60, 130; 70, 125
3690  LINE 88, 107; 88, 70;
3700  LINE 212, 107; 212, 70
3710  LINE 88, 73; 212, 73
3720  AREA 88, 73; 94, 75; 94, 71
3730  AREA 130, 73; 124, 75; 124, 71
3740  AREA 170, 73; 176, 75; 176, 71
3750  AREA 212, 73; 206, 75; 206, 71
3760  PLOT "X", 106, 74; 187, 74
3770  PLOT "O", 106, 109; 190, 109
3780  SET BRUSH 15 : AREA 5, 60; 314, 60; 314, 20; 5, 20
```

```
3790  SET BRUSH 0 : PLOT "REF = M - 2(d/2+X)", 60, 50
3800  PLOT "tanA=d/2X : 2X=d/tanA : 2X=d*cotanA", 10, 35
3810  SET BRUSH 3 : PLOT "REF = M - d(1+cotanA)", 60, 20
3820  SET PEN 15 : SET CURPOS 2, 24 : PRINT "     PRESS ANY KEY TO CONTINUE"
3830  Answer$ := GET$() : CLG
3840  CLG : HOME
3850  Total := 0 : Count := 0
3860  SET PEN 4 : SET PAPER 14 : CLS : PRINT TAB (15); "EXAMPLES"
3870  PRINT #2, ! ! TAB (15); "EXAMPLES"
3880  PRINT TAB (15); "========"
3890  PRINT #2, TAB (15); "========"
3900  SET PEN 9 : PRINT ! TAB (8); "REF = M - d(1+CotanA)"
3910  PRINT #2, ! TAB (8); "REF = M - d(1+CotanA)"
3920  M := (RND(50)) + 75
3930  D := 25 : A := 30 : REM CONSTANT VALUES OF DIAMETER AND ANGLE
3940  Ref := M - 25 * ( 2.732051)
3950  PRINT ! TAB (10); "IF THE READING M IS"; M; "mm,"
3960  PRINT #2, ! TAB (10); "IF THE READING M IS"; M; "mm,"
3970  PRINT ! TAB (10); "THE DIAMETER,d=25 mm"
3980  PRINT #2, ! TAB (10); "THE DIAMETER,d=25 mm"
3990  PRINT ! TAB (10); "AND THE ANGLE,A=30 deg"
4000  PRINT #2, ! TAB (10); "AND THE ANGLE,A=30 deg"
4010  PRINT ! TAB (5); "THEN CALCULATE THE VALUE OF REF"
4020  PRINT #2, ! TAB (5); "THEN CALCULATE THE VALUE OF REF"
4030  PRINT ! TAB (5) "INPUT YOUR ANSWER"; : INPUT R0
4040  PRINT #2, ! TAB (5) "INPUT YOUR ANSWER"; : PRINT #2, R0,
4050  IF ABS(Ref - R0) < 0.1 THEN PLOT "CORRECT", 70, 10 SIZE 3 ELSE 4090
4060  IF ABS(Ref - R0) < 0.1 THEN PRINT #2, "CORRECT"
4070  FOR I := 1 TO 1000 : NEXT I
4080  GOTO 4150
```

```
4090   PRINT TAB (3) "NO!That is NOT right,try again"
4100   PRINT #2, TAB (3) "NO!That is NOT right,try again"
4110   Total := Total + 1
4120   IF Total < 3 THEN 4030
4130   GOSUB 4180
4140   GOTO 3850
4150   Count := Count + 1
4160   IF Count < 4 THEN CLS : HOME : GOTO 3860
4170   GOTO 4270
4180   PRINT ! "THIS IS THE CORRECT METHOD OF SOLUTION"
4190   PRINT #2, ! "THIS IS THE CORRECT METHOD OF SOLUTION"
4200   PRINT ! TAB (5); "REF = M - d(1+cotanA)"
4210   PRINT #2, ! TAB (5); "REF = M - d(1+cotanA)"
4220   PRINT ! TAB (5); M; "-25(1+cotan30)="; Ref; "mm"
4230   PRINT #2, ! TAB (5); M; "-25(1+cotan30)="; Ref; "mm"
4240   FOR I := 1 TO 3000 : NEXT I
4250   CLG : HOME
4260   RETURN
4270 ENDPROC
4280 PROCEDURE Graph
4290   GLOBAL Fred$
4300   PRINT #2, Fred$
4310   PRINT #2, "Graphs"
4320   CLG : SET BRUSH 0 : AREA 35, 95; 25, 105; 25, 185; 35, 195; 295, 195; 305, 185; 305, 105; 295, 95
4330   SET BRUSH 15 : AREA 30, 100; 20, 110; 20, 190; 30, 200; 290, 200; 300, 190; 300, 110; 290, 100
4340   SET BRUSH 10 : PLOT "GRAPHS", 65, 140 SIZE 4
4350   PLOT "F & N LEVEL", 30, 110 SIZE 3
4360   FOR I := 1 TO 2000 : NEXT I
4370   CLS : HOME
```

```
4380  AREA 0, 0; 0, 249; 319, 249; 319, 0 BRUSH 4 STYLE 3
4390  AREA 2, 2; 2, 247; 317, 247; 317, 2 BRUSH 4 STYLE 3
4400  SET BRUSH 14 : PLOT "GRAPHS", 140, 225
4410  PLOT "(1) STRAIGHT LINE GRAPHS:  Y = AX+B ", 10, 205
4420  PLOT "(2) QUADRATIC GRAPHS:  Y=AX*X+BX+C", 10, 185
4430  PLOT "CHOOSE A NUMBER AND PRESS ENTER KEY. ", 20, 125
4440  PLOT "YOU WILL NEED A CALCULATOR.", 45, 105
4450  SET CURPOS 20, 20
4460  Count := 1
4470  INPUT Choose
4480  ON Choose GOSUB 4500, 5460
4490  IF Choose > 2 THEN 4370
4500  Axes
4510  FOR Count := 1 TO 10 STEP 2
4520   A := RND(6)
4530   B := RND(10)
4540   X1 := - 100 : Y1 := A * X1 + B * 10
4550   X2 := 100 : Y2 := A * X2 + B * 10
4560   SET BRUSH Count
4570   LINE X1, Y1; X2, Y2
4580   SET WRITING 1 TO 50, 20; 60, 22
4590   SET WRITING 1 : SET PAPER 3
4600   CLS
4610   SET WRITING 1 : INPUT " A"; A1 : IF ABS(A1 - A) < 1 THEN PRINT "  CORRECT" ELSE PRINT "  TRY AGAIN"
       : GOTO 4610
4620   INPUT " B"; B1 : IF ABS(B1 - B) < 1 THEN PRINT "  CORRECT" ELSE PRINT " TRY AGAIN" : GOTO 4620
4630   SET BRUSH 3 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
4640   Answer$ := GET$()
4650   SET BRUSH 0 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
```

```
4660    CLS
4670  NEXT Count
4680  Axes
4690  FOR Count := 1 TO 10 STEP 2
4700    A := - (RND(6)) : B := RND(10)
4710    X1 := - 100 : Y1 := A * X1 + B * 10
4720    X2 := 100 : Y2 := A * X2 + B * 10
4730    SET BRUSH Count
4740    LINE X1, Y1; X2, Y2
4750    SET WRITING 1 TO 50, 20; 60, 22
4760    SET WRITING 1 : SET PAPER 3
4770    CLS
4780    SET WRITING 1 : INPUT " A"; A1 : IF ABS(A1 - A) < 1 THEN PRINT "  CORRECT" ELSE PRINT "  TRY AGAIN"
        : GOTO 4780
4790    INPUT " B"; B1 : IF ABS(B1 - B) < 1 THEN PRINT " CORRECT" ELSE PRINT "  TRY AGAIN" : GOTO 4790
4800    SET BRUSH 3 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
4810    Answer$ := GET$()
4820    SET BRUSH 0 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
4830  CLS : NEXT Count
4840  Axes
4850  FOR Count := 1 TO 10 STEP 2
4860    A := RND(6) : B := - (RND(10))
4870    X1 := - 100 : Y1 := A * X1 + B * 10
4880    X2 := 100 : Y2 := A * X2 + B * 10
4890    SET BRUSH Count
4900    LINE X1, Y1; X2, Y2
4910    SET WRITING 1 TO 50, 20; 60, 22 : SET WRITING 1 : SET PAPER 3
4920    CLS
4930    SET WRITING 1 : INPUT " A"; A1 : IF ABS(A1 - A) < 1 THEN PRINT "  CORRECT" ELSE PRINT "  TRY AGAIN"
```

```
        : GOTO 4930
4940    INPUT " B"; B1 : IF ABS(B1 - B) < 1 THEN PRINT "  CORRECT" ELSE PRINT "  TRY AGAIN" : GOTO 4940
4950    SET BRUSH 3 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
4960    Answer$ := GET$()
4970    SET BRUSH 0 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
4980  CLS : NEXT Count
4990  Axes
5000  FOR Count := 1 TO 10 STEP 2
5010    A := - (RND(6)) : B := - (RND(10))
5020    X1 := - 100 : Y1 := A * X1 + B * 10
5030    X2 := 100 : Y2 := A * X2 + B * 10
5040    SET BRUSH Count
5050    LINE X1, Y1; X2, Y2
5060    SET WRITING 1 TO 50, 20; 60, 22
5070    SET WRITING 1 : SET PAPER 3
5080    CLS
5090    SET WRITING 1 : INPUT " A"; A1 : IF ABS(A1 - A) < 1 THEN PRINT "  CORRECT" ELSE PRINT "  TRY AGAIN"
        : GOTO 5090
5100    INPUT " B"; B1 : IF ABS(B1 - B) < 1 THEN PRINT "  CORRECT " ELSE PRINT "  TRY AGAIN" : GOTO 5100
5110    SET BRUSH 3 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
5120    Answer$ := GET$()
5130    SET BRUSH 0 : PLOT "PRESS ANY KEY TO CONTINUE", 20, - 90
5140  CLS : NEXT Count
5150  SET WRITING 0
5160 ENDPROC
5170 PROCEDURE Axes
5180  SET MODE 80, 200, 200
5190  SET ORIGIN 100, 100
5200  SET PEN 2
```

```
5210   SET BRUSH 3
5220   LINE - 100, 0; 100, 0
5230   LINE 0, - 100; 0, 100
5240   FOR I := 0 TO 200 STEP 5
5250     LINE - 100 + I, 5; - 100 + I, 0
5260   NEXT I
5270   FOR J := 0 TO 200 STEP 5
5280     LINE - 5, - 100 + J; 0, - 100 + J
5290   NEXT J
5300   FOR In := 0 TO 200 STEP 10
5310     LINE - 100 + In, - 5; - 100 + In, 0
5320   NEXT In
5330   FOR Vin := 0 TO 200 STEP 10
5340     LINE 3, - 100 + Vin; 0, - 100 + Vin
5350   NEXT Vin
5360   SET BRUSH 2
5370   PLOT "-10", 3, - 102; - 100, - 19
5380   PLOT "-5", 3, - 52; - 52, - 19
5390   PLOT "5", 5, 48; 50, - 19
5400   PLOT "10", 5, 95; 95, - 19
5410   PLOT "Y = AX + B", - 90, 90
5420   PLOT "Determine the values", - 90, 80
5430   PLOT "of A and B from the graph.", - 90, 70
5440   PLOT "A and B are integers.", - 90, 60
5450 ENDPROC
5460 FOR Count := 1 TO 10 STEP 2
5470   Axes2
5480   Text
5490   A := RND(3) : B := - (RND(5)) : C := - (RND(8))
```

```
5500   FOR X := - 10 TO 10 STEP  0.2
5510     Y := A * X*X + B * X + C
5520     SET BRUSH 2
5530     POINTS X * 5, Y STYLE 2
5540   NEXT X
5550   R1 := (- B - SQRT(B 2 - 4 * A * C)) / (2 * A)
5560   R2 := (- B + SQRT(B 2 - 4 * A * C)) / (2 * A)
5570   SET CURPOS 50, 3 : SET PEN 3 : PRINT "Y = "; A; "X 2 "; B; "X "; C
5580   SET PEN 3 : SET CURPOS 50, 6 : CLL 2
5590   INPUT "INPUT LEFT ROOT" Left1
5600   SET CURPOS 50, 7 : IF ABS(R1 - Left1) <  0.15 THEN PRINT "LEFT ROOT CORRECT" ELSE 5580
5610   SET CURPOS 50, 8 : PRINT "TRUE VALUE ="; R1
5620   FOR I := 1 TO 1000 : NEXT I : SET CURPOS 50, 10 : CLL 2
5630   INPUT "INPUT RIGHT ROOT" Right1
5640   SET CURPOS 50, 11 : IF ABS(R2 - Right1) <  0.15 THEN PRINT "RIGHT ROOT CORRECT" ELSE 5620
5650   SET CURPOS 50, 12 : PRINT "TRUE VALUE =", R2
5660 FOR I := 1 TO 2000 : NEXT I : NEXT Count
5670 FOR Count := 1 TO 10 STEP 2
5680   Axes2
5690   Text1
5700   A := RND(3) : B := - (RND(5)) : C := - (RND(8))
5710   FOR X := - 10 TO 10 STEP  0.2
5720     Y := A * X  2 + B * X + C
5730     SET BRUSH 2
5740     POINTS X * 5, Y STYLE 2
5750   NEXT X
5760   R1 := (- B - SQRT(B 2 - 4 * A * C)) / (2 * A)
5770   R2 := (- B + SQRT(B 2 - 4 * A * C)) / (2 * A)
5780   SET CURPOS 50, 3 : SET PEN 3 : PRINT "Y = "; A; "X 2 "; B; "X "; C
```

```
5790 ENDPROC
5800 SET PEN 3 : SET CURPOS 50, 6 : CLL 2
5810 INPUT "INPUT LEFT ROOT" Left1
5820 SET CURPOS 50, 7 : IF ABS(R1 - Left1) <  0.15 THEN PRINT "LEFT ROOT CORRECT" ELSE 5800
5830 SET CURPOS 50, 8 : PRINT "TRUE VALUE ="; R1
5840 FOR I := 1 TO 1000 : NEXT I : SET CURPOS 50, 10 : CLL 2
5850 INPUT "INPUT RIGHT ROOT" Right1
5860 SET CURPOS 50, 11 : IF ABS(R2 - Right1) <  0.15 THEN PRINT "RIGHT ROOT CORRECT" ELSE 5840
5870 SET CURPOS 50, 12 : PRINT "TRUE VALUE =", R2
5880 FOR I := 1 TO 2000 : NEXT I : NEXT Count
5890 SET MODE 40 : GOTO 310
5900 PROCEDURE Round
5910   GLOBAL Fred$
5920   PRINT #2, Fred$
5930   PRINT #2, "Properties of a Circle"
5940   CLG : SET BRUSH 0 : AREA 35, 95; 25, 105; 25, 185; 35, 195; 295, 195; 305, 185; 305, 105; 295, 95
5950   SET BRUSH 15 : AREA 30, 100; 20, 110; 20, 190; 30, 200; 290, 200; 300, 190; 300, 110; 290, 100
5960   SET BRUSH 4 : PLOT "TERMINOLOGY", 75, 170 SIZE 2
5970   PLOT "AND PROPERTIES OF", 27, 150 SIZE 2
5980   PLOT "THE CIRCLE", 80, 130 SIZE 2
5990   SET BRUSH 9 : PLOT "F LEVEL", 100, 100 SIZE 2
6000   FOR I := 1 TO 2000 : NEXT I
6010   CLG : SET BRUSH 4 : PLOT "TERMINOLOGY & PROPERTIES OF THE CIRCLE", 10, 235
6020   SET BRUSH 4 : CIRCLE 50, 160, 180 STYLE 3
6030   PLOT "O", 157, 173
6040   PLOT "A circle is a plane figure enclosed by a", 1, 115
6050   PLOT "curved line,every point on which is equi", 1, 105
6060   PLOT "distant from a point within called the", 1, 95
6070   PLOT "CENTRE.O is the centre of the circle.", 1, 85
```

```
6080  FOR I := 1 TO 5000 : NEXT I
6090  SET BRUSH 2 : LINE 160, 180; 208, 190
6100  PLOT "A", 212, 190
6110  PLOT "r", 180, 190
6120  PLOT "The distance from the centre to the ", 15, 75
6130  PLOT "curve,OA,is called the RADIUS,r, of the", 1, 65
6140  PLOT "circle.", 1, 55
6150  FOR I := 1 TO 3000 : NEXT I
6160  SET BRUSH 15 : LINE 160, 130; 160, 230
6170  PLOT "B", 162, 218
6180  PLOT "C", 162, 130
6190  PLOT "Any straight line passing through the", 15, 45
6200  PLOT "d", 150, 180
6210  PLOT "centre and touching the circumference", 15, 35
6220  PLOT "at each end as BC does is called the", 15, 25
6230  PLOT "DIAMETER,d.The diameter is twice the", 15, 15
6240  PLOT "length of the radius.d=2r.", 15, 5 : FOR I := 1 TO 5000 : NEXT I
6250  PLOT "PRESS SPACE-BAR", 5, 135
6260  PLOT "TO CONTINUE", 5, 125
6270  Answer$ := GET$() : CLG
6280  CIRCLE 50, 160, 180 STYLE 3
6290  SET BRUSH 6 : LINE 160, 130; 160, 230
6300  PLOT "d", 165, 185 : SET BRUSH 15
6310  SET BRUSH 6
6320  PLOT "The boundary of a circle,that is the", 15, 115
6330  PLOT "perimeter,is called the CIRCUMFERENCE,", 15, 105
6340  PLOT "c.c/d is equal to the constant PI.", 15, 95
6350  PLOT "PI=3.142 to three decimal places.", 15, 85
6360  SET DEG TRUE : SLICE 50, 0 TO 115, 160, 180 STYLE 3
```

```
6370  SET BRUSH 1 : LINE 160, 180; 205, 159
6380  SET BRUSH 15 : PLOT "O", 157, 174
6390  SET BRUSH 6 : POINTS 205, 159; 160, 180
6400  FOR I := 1 TO 6000 : NEXT I
6410  SET BRUSH 5 : LINE 97, 130; 119, 230 : LINE 160, 180; 112, 191
6420  SET BRUSH 15 : PLOT "H", 100, 192 : SET BRUSH 5 : PLOT "F", 88, 125
6430  PLOT "G", 110, 230
6440  PLOT "A TANGENT to a circle is a straight", 15, 65
6450  PLOT "line which meets the circle at one", 15, 55
6460  PLOT "point,H.FG is a Tangent to the circle.", 15, 45
6470  PLOT "If radius OH is drawn then FHO is", 15, 35
6480  PLOT "a RIGHT-ANGLE.", 15, 25 : FOR I := 1 TO 7000 : NEXT I
6490  SET BRUSH 3 : PLOT "PRESS SPACE-BAR TO CONTINUE.", 50, 5
6500  Answer$ := GET$() : CLG
6510  SET BRUSH 2 : SLICE 50, 60 TO 120, 160, 180
6520  SET BRUSH 15 : CIRCLE 50, 160, 180 STYLE 3
6530  SET BRUSH 15 : PLOT "O", 155, 177
6540  PLOT "X", 210, 150 : PLOT "Y", 210, 200
6550  PLOT "The shaded portion OXY is called a", 5, 115
6560  PLOT "SECTOR.", 5, 105
6570  PLOT "If the sector is less than a semi-", 5, 95
6580  PLOT "circle it is a MINOR SECTOR.If larger", 5, 85
6590  PLOT "than a semi-circle it is a MAJOR SECTOR.", 5, 75
6600  FOR I := 1 TO 3000 : NEXT I
6610  LINE 132, 138; 160, 230
6620  PLOT "U", 122, 130
6630  PLOT "V", 160, 230
6640  PLOT "The line UV is a CHORD.", 5, 65
6650  FOR I := 1 TO 1000 : NEXT I
```

```
6660  SET BRUSH 5 : FLOOD 130, 180
6670  PLOT "The shaded portion UV is a SEGMENT.", 5, 55
6680  PLOT "The shortest distance between U and V ", 5, 45
6690  PLOT "along the circumference is called the", 5, 35
6700  PLOT "MINOR ARC.The remaining part of the", 5, 25
6710  PLOT "circumference is the MAJOR ARC.", 5, 15
6720  FOR I := 1 TO 2000 : NEXT I
6730  SET BRUSH 4 : PLOT "PRESS THE SPACE BAR  TO CONTINUE.", 30, 5
6740  Answer$ := GET$() : CLG
6750  CIRCLE 50, 160, 180 STYLE 3
6760  SET BRUSH 15 : SLICE 50, 0 TO 57, 160, 180 STYLE 3
6770  PLOT "O", 165, 190
6780  PLOT "r", 185, 185; 185, 230
6790  PLOT "An angle can be measured in DEGREES or", 2, 115
6800  PLOT "RADIANS.A RADIAN is defined as the angle", 2, 105
6810  PLOT "formed at the centre of a circle by an", 2, 95
6820  PLOT "ARC equal in length to the RADIUS.", 2, 85
6830  PLOT "0 = 1 radian = 57.3 deg.", 30, 65
6840  PLOT "2xPI radians = 360 degs.", 60, 45
6850  SET BRUSH 3 : PLOT "PRESS SPACE BAR TO CONTINUE", 50, 15
6860  Answer$ := GET$() : CLG
6870  SET BRUSH 2 : CIRCLE 50, 160, 180
6880  SET BRUSH 15 : PLOT "r", 185, 185
6890  LINE 160, 180; 210, 180
6900  PLOT "2", 235, 115; 180, 98
6910  PLOT "Area of a circle = PIxr", 50, 110
6920  PLOT "or PIxd", 125, 90
6930  PLOT "-----", 150, 85
6940  PLOT "4", 160, 80
```

```
6950   PLOT "Have a go at the following questions.", 10, 50
6960   PLOT "PRESS SPACE BAR TO CONTINUE", 50, 30
6970   Answer$ := GET$()
6980   Round1
6990   Round2
7000   Round3
7010   Round4
7020   Round5
7030 ENDPROC
7040 PROCEDURE Round1
7050   CLG : SET PAPER 1 : SET BRUSH 8
7060   CIRCLE 40, 170, 200
7070   SET BRUSH 4 : LINE 170, 200; 210, 200
7080   PLOT "r", 177, 200
7090   PLOT "AREA OF A CIRCLE          PROBLEM", 1, 220
7100   Total := 0 : Count := 0
7110   SET WRITING 1 TO 1, 11; 40, 15
7120   SET WRITING 2 TO 1, 16; 40, 25
7130   LINE 0, 150; 319, 150
7140   SET WRITING 1 : SET PAPER 15
7150   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
7160   R := RND(50)
7170   PRINT 1, "If the radius r ="; R; "cm then calculate"
7180   PRINT #2 !, "If the radius r ="; R; "cm then calculate"
7190   PRINT 1; TAB (3); "the area of the circle shown above."
7200   PRINT #2 !; TAB (3); "the area of the circle shown above."
7210   SET CURPOS 0, 1 : PRINT 2 ! "Input your answer for the area";
7220   SET WRITING 2 : INPUT A1 : PRINT #2 !; "AREA = "; A1
7230   A := PI * R * R
```

```
7240   IF ABS(A - A1) <  1e-02 THEN SET BRUSH 1 : PLOT "WELL DONE", 60, 10 SIZE 3 ELSE 7270
7250   IF ABS(A - A1) <  1e-02 THEN PRINT #2 !, "WELL DONE"
7260   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(A - A1) <  1e-02 THEN 7350
7270   PRINT 2, TAB (2) "No! You have made a mistake,try again"
7280   PRINT #2 !, TAB (2) "No! You have made a mistake,try again"
7290   FOR I := 1 TO 1000 : NEXT I
7300   CLS 2
7310   Total := Total + 1
7320   IF Total < 3 THEN 7210
7330   GOSUB 7380
7340   GOTO 7050
7350   Count := Count + 1
7360   IF Count < 4 THEN 7150
7370   GOTO 7470
7380   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
7390   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
7400   PRINT 2 !, TAB (7) "AREA = PIxRADIUSxRADIUS"
7410   PRINT #2 !, TAB (7) "AREA = PIxRADIUSxRADIUS"
7420   PRINT 2, TAB (7) "AREA = "; PI * R * R; "CM2"
7430   PRINT #2 !, TAB (7) "AREA = "; PI * R * R; "CM2"
7440   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
7450   Answer$ := GET$()
7460   RETURN
7470 ENDPROC
7480 PROCEDURE Round2
7490   CLG : SET PAPER 1 : SET BRUSH 8
7500   CIRCLE 40, 170, 200
7510   SET BRUSH 4 : LINE 130, 200; 210, 200
7520   PLOT "d", 168, 200
```

```
7530  PLOT "AREA OF A CIRCLE          PROBLEM", 1, 220
7540  Total := 0 : Count := 0
7550  SET WRITING 1 TO 1, 11; 40, 15
7560  SET WRITING 2 TO 1, 16; 40, 25
7570  LINE 0, 150; 319, 150
7580  SET WRITING 1 : SET PAPER 15
7590  SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
7600  D := RND(25)
7610  PRINT 1, "If the diameter d="; D; "cm then calculate"
7620  PRINT #2 !, "If the diameter d ="; D; "cm then calculate"
7630  PRINT 1; TAB (3); "the area of the circle shown above."
7640  PRINT #2 !; TAB (3); "the area of the circle shown above."
7650  SET CURPOS 0, 1 : PRINT 2 ! TAB (2) "Input your answer for the area";
7660  SET WRITING 2 : INPUT A1 : PRINT #2; "AREA = "; A1
7670  A := PI * D * D / 4
7680  IF ABS(A - A1) <  1e-02 THEN SET BRUSH 1 : PLOT "WELL DONE", 60, 10 SIZE 3 ELSE 7710
7690  IF ABS(A - A1) <  1e-02 THEN PRINT #2 !, "WELL DONE"
7700  FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(A - A1) <  1e-02 THEN 7790
7710  PRINT 2, TAB (2) "No! You have made a mistake,try again"
7720  PRINT #2 !, TAB (2) "No! You have made a mistake,try again"
7730  FOR I := 1 TO 1000 : NEXT I
7740  CLS 2
7750  Total := Total + 1
7760  IF Total < 3 THEN 7650
7770  GOSUB 7820
7780  GOTO 7490
7790  Count := Count + 1
7800  IF Count < 4 THEN 7590
7810  GOTO 7910
```

```
7820   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
7830   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
7840   PRINT 2 !, TAB (7) "AREA = PIxDIA*DIA"
7850   PRINT #2 !, TAB (7) "AREA = PIxDIAxDIA"
7860   PRINT 2, TAB (7) "AREA = "; PI * D * D; "CM2"
7870   PRINT #2 !, TAB (7) "AREA = "; PI * D * D; "CM2"
7880   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
7890   Answer$ := GET$()
7900   RETURN
7910 ENDPROC
7920 PROCEDURE Round3
7930   CLG : SET PAPER 15 : SET BRUSH 8
7940   CIRCLE 40, 170, 200 STYLE 3
7950   SET DEG FALSE
7960   SET BRUSH 4 : SLICE 40, 1 TO 2, 170, 200
7970   SET BRUSH 15 : PLOT "O", 180, 195
7980   SET BRUSH 8 : PLOT "A", 205, 220
7990   PLOT "B", 205, 168
8000   PLOT "r", 185, 210
8010   PLOT "LENGTH OF ARC", 1, 235
8020   PLOT "PROBLEM", 5, 225
8030   PLOT " ARC,AB = RADIUS X O(RAD)", 1, 148
8040   Total := 0 : Count := 0
8050   SET WRITING 1 TO 1, 12; 40, 15
8060   SET WRITING 2 TO 1, 16; 40, 25
8070   LINE 0, 148; 319, 148
8080   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
8090   SET DEG FALSE
8100   R := RND(20) + 5 : Angle := RND(1) * 2 * PI
```

```
8110  PRINT 1, TAB (5); "If the radius ="; R; "cm and the"
8120  PRINT #2 !, TAB (5); "If the radius ="; R; "cm and the"
8130  PRINT 1, TAB (5) "angle = " Angle; " rads then"
8140  PRINT #2 !, TAB (5) "angle = " Angle; " rads then"
8150  PRINT 1, TAB (5) "calculate the ARC length AB"
8160  PRINT #2 !, TAB (5) "calculate the ARC length AB"
8170  SET CURPOS 0, 1 : PRINT 2 ! " Input your answer for the arc length          ";
8180  SET WRITING 2 : INPUT Arc1 : PRINT #2 !; "ARC = "; Arc1
8190  Arc := R * Angle
8200  IF ABS(Arc - Arc1) <  1e-02 THEN SET BRUSH 1 : PLOT "WELL DONE", 60, 10 SIZE 3 ELSE 8230
8210  IF ABS(Arc - Arc1) <  1e-02 THEN PRINT #2 !, "WELL DONE"
8220  FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Arc - Arc1) <  1e-02 THEN 8310
8230  PRINT 2, TAB (2) "No! You have made a mistake,try again"
8240  PRINT #2 !, TAB (2) "No! You have made a mistake,try again"
8250  FOR I := 1 TO 1000 : NEXT I
8260  CLS 2
8270  Total := Total + 1
8280  IF Total < 3 THEN 8170
8290  GOSUB 8340
8300  GOTO 7930
8310  Count := Count + 1
8320  IF Count < 4 THEN 8080
8330  GOTO 8430
8340  SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
8350  PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
8360  PRINT 2 !, TAB (7) "ARC =RADIUS X ANGLE(RAD)"
8370  PRINT #2 !, TAB (7) "ARC =RADIUS X ANGLE(RAD)"
8380  PRINT 2, TAB (7) "ARC = "; R * Angle; "CM"
8390  PRINT #2 !, TAB (7) "ARC = "; R * Angle; "CM"
```

```
8400   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
8410   Answer$ := GET$()
8420   RETURN
8430 ENDPROC
8440 PROCEDURE Round4
8450   CLG : SET PAPER 15 : SET BRUSH 8
8460   CIRCLE 40, 170, 200 STYLE 3
8470   SET BRUSH 4 : SLICE 40, 1 TO 2, 170, 200
8480   SET BRUSH 15 : PLOT "O", 180, 195
8490   SET BRUSH 8 : PLOT "A", 205, 220
8500   PLOT "B", 205, 168
8510   PLOT "r", 185, 210
8520   PLOT "LENGTH OF ARC", 1, 235
8530   PLOT "PROBLEM", 5, 225
8540   PLOT " ARC,AB = RADIUS X O(RAD)", 1, 148
8550   Total := 0 : Count := 0
8560   SET WRITING 1 TO 1, 12; 40, 15
8570   SET WRITING 2 TO 1, 16; 40, 25
8580   LINE 0, 148; 319, 148
8590   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
8600   SET DEG FALSE
8610   R := RND(20) + 5 : Arc := RND(40) + 10
8620   PRINT 1, TAB (5); "If the radius ="; R; "cm and the"
8630   PRINT #2 !, TAB (5); "If the radius ="; R; "cm and the"
8640   PRINT 1, TAB (5) "ARC = " Arc; " cm then"
8650   PRINT #2 !, TAB (5) "ARC = " Arc; " cm then"
8660   PRINT 1, TAB (5) "calculate the angle O in rads"
8670   PRINT #2 !, TAB (5) "calculate the angle O in rads"
8680   SET CURPOS 0, 1 : PRINT 2 ! TAB (5) "Input your answer for the angle O"
```

```
8690   SET WRITING 2 : INPUT Angle1 : PRINT #2 !; "angle = "; Angle1
8700   Angle := Arc / R
8710   IF ABS(Angle - Angle1) <  1e-02 THEN SET BRUSH 1 : PLOT "THAT'S RIGHT", 20, 10 SIZE 3 ELSE 8740
8720   IF ABS(Angle - Angle1) <  1e-02 THEN PRINT #2 !, "THAT'S RIGHT"
8730   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Angle - Angle1) <  1e-02 THEN 8820
8740   PRINT 2, TAB (2) "No! You have made a mistake,try again"
8750   PRINT #2 !, TAB (2) "No! You have made a mistake,try again"
8760   FOR I := 1 TO 1000 : NEXT I
8770   CLS 2
8780   Total := Total + 1
8790   IF Total < 3 THEN 8680
8800   GOSUB 8850
8810   GOTO 8450
8820   Count := Count + 1
8830   IF Count < 4 THEN 8590
8840   GOTO 8940
8850   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
8860   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
8870   PRINT 2 !, TAB (7) "ANGLE 0 =ARC/RADIUS"
8880   PRINT #2 !, TAB (7) "ANGLE 0 = ARC/RADIUS"
8890   PRINT 2, TAB (7) "ANGLE = "; Arc / R; "Rads"
8900   PRINT #2 !, TAB (7) "ANGLE = "; Arc / R; "Rads"
8910   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
8920   Answer$ := GET$()
8930   RETURN
8940 ENDPROC
8950 PROCEDURE Round5
8960   CLG : SET PAPER 15 : SET BRUSH 8
8970   CIRCLE 40, 170, 200 STYLE 3
```

```
8980  PLOT "AREA OF SECTOR", 20, 235
8990  PLOT "PROBLEMS", 35, 225
9000  PLOT " AREA OF SECTOR = RADxRADxANGLE(rads)/2", 0, 148
9010  Total := 0 : Count := 0
9020  SET WRITING 1 TO 1, 12; 40, 15
9030  SET WRITING 2 TO 1, 16; 40, 25
9040  LINE 0, 148; 319, 148
9050  SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
9060  SET DEG FALSE
9070  R := RND(20) + 5 : Angle := RND(1) * 2 * PI +  0.25
9080  SET BRUSH 4 : SLICE 40, 0 TO Angle, 170, 200
9090  PRINT 1; TAB (5) "If the radius ="; R; "cm and the"
9100  PRINT #2 !, TAB (5); "If the radius ="; R; "cm and the"
9110  PRINT 1, "angle = " Angle; " rads then calculate"
9120  PRINT #2 !, TAB (5) "angle = " Angle; " rads then"
9130  PRINT 1, "the area of the SECTOR in cm2"
9140  PRINT #2 !, TAB (5) "calculate the area of the SECTOR in cm2"
9150  SET CURPOS 0, 1 : PRINT 2 ! TAB (5) "Input your answer for the area"
9160  SET WRITING 2 : INPUT Area1 : PRINT #2 !; "area = "; Area1
9170  Sector Area := R * R * Angle / 2
9180  IF ABS(Sector Area - Area1) <  1e-02 THEN SET BRUSH 1 : PLOT "THAT'S RIGHT", 20, 10 SIZE 3 ELSE 9210
9190  IF ABS(Sector Area - Area1) <  1e-02 THEN PRINT #2 !, "THAT'S RIGHT"
9200  FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Sector Area - Area1) <  1e-02 THEN 9290
9210  PRINT 2, TAB (2) "No! You have made a mistake,try again"
9220  PRINT #2 !, TAB (2) "No! You have made a mistake,try again"
9230  FOR I := 1 TO 1000 : NEXT I
9240  CLS 2
9250  Total := Total + 1
9260  IF Total < 3 THEN 9150
```

```
9270   GOSUB 9320
9280   GOTO 8960
9290   Count := Count + 1
9300   IF Count < 4 THEN 9050
9310   GOTO 9410
9320   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
9330   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION."
9340   PRINT 2 !, TAB (2) "AREA OF SECTOR = RAD x RAD x ANGLE/2"
9350   PRINT #2 !, TAB (7) "AREA OF SECTOR = RAD x RAD x ANGLE/2"
9360   PRINT 2, TAB (2) "AREA OF SECTOR = "; R * R * Angle / 2; "cm2"
9370   PRINT #2 !, TAB (7) "AREA OF SECTOR = "; R * R * Angle / 2; "cm2"
9380   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
9390   Answer$ := GET$()
9400   RETURN
9410 ENDPROC
9420 PROCEDURE Axes2
9430   SET MODE 80, 100, 120
9440   SET ORIGIN 50, 20
9450   SET PEN 2
9460   SET BRUSH 3
9470   LINE - 50, 0; 50, 0
9480   LINE 0, - 20; 0, 100
9490   FOR I := 0 TO 110 STEP  2.5
9500     LINE - 50 + I, 1; - 50 + I, 0
9510   NEXT I
9520   FOR J := 0 TO 120 STEP 5
9530     LINE -  0.5, - 20 + J; 0, - 20 + J
9540   NEXT J
9550   FOR In := 0 TO 100 STEP  1.25
```

```
9560     LINE - 50 + In, - 1; - 50 + In, 0
9570   NEXT In
9580   FOR Vin := 0 TO 120 STEP  2.5
9590     LINE  0.3, - 20 + Vin; 0, - 20 + Vin
9600   NEXT Vin
9610   SET BRUSH 2
9620   PLOT "-10", - 50, - 8
9630   PLOT "-5", - 27, - 8
9640   PLOT "5", 25, - 8
9650   PLOT "10", 48, - 8
9660   PLOT "-20", 2, - 21
9670   PLOT "20", 3, 18
9680   PLOT "40", 3, 38
9690   PLOT "60", 3, 58
9700   PLOT "80", 3, 78
9710   PLOT "100", 3, 96
9720   SET BRUSH 3
9730 ENDPROC
9740 PROCEDURE Text
9750   PLOT "Y = AXxX  + BX + C", - 45, 90
9760   PLOT "Determine the values", - 45, 85
9770   PLOT "of the ROOTS of the", - 45, 80
9780   PLOT "equation from the graph.", - 45, 75
9790 ENDPROC
9800 PROCEDURE Text1
9810   PLOT "Calculate the ROOTS of", - 45, 85
9820   PLOT "the equation shown", - 45, 80
9830   PLOT "by using the general formula", - 45, 75
9840 ENDPROC
```

```
9850 PROCEDURE Trig1
9860   GLOBAL Fred$
9870   PRINT #2, Fred$
9880   PRINT #2, "Trigonometry"
9890   CLG : SET PAPER 1 : SET BRUSH 0 : AREA 35, 95; 25, 105; 25, 185;
       35, 195; 295, 195; 305, 185; 305, 105; 295, 95
9900   SET BRUSH 15 : AREA 30, 100; 20, 110; 20, 190; 30, 200; 290, 200; 300, 190; 300, 110; 290, 100
9910   SET BRUSH 8 : PLOT "TRIGONOMETRY", 20, 150 SIZE 3
9920   SET BRUSH 3 : PLOT "F LEVEL", 80, 120 SIZE 3
9930   FOR I := 1 TO 1000 : NEXT I
9940   CLG : SET BORDER 1 : SET BRUSH 15 : PLOT "INTRODUCTION TO TRIGONOMETRY", 50, 230
9950   PLOT "THE RIGHT-ANGLED TRIANGLE", 60, 220
9960   SET BRUSH 15 : AREA 10, 150; 100, 210; 100, 150 STYLE 3
9970   LINE 90, 150; 90, 160; 100, 160
9980   PLOT "A", 5, 140 : PLOT "B", 105, 140 : PLOT "C", 105, 210
9990   SET BRUSH 10 : PLOT "a", 105, 175 : PLOT "b", 45, 185 : PLOT "c", 50, 140
10000  PLOT "SINE A = a/b", 5, 120
10010  PLOT "COSINE A = c/b", 5, 110
10020  PLOT "TANGENT A = a/c", 5, 100
10030  SET BRUSH 14 : PLOT "SINE C = c/b", 5, 80
10040  PLOT "COSINE C = a/b", 5, 70
10050  PLOT "TANGENT C = c/a", 5, 60
10060  SET BRUSH 6 : PLOT "From the above it", 5, 40
10070  PLOT "can be seen that", 5, 30
10080  PLOT "SIN A = COS C", 5, 20
10090  PLOT "COS A = SIN C", 5, 10
10100  PLOT "TAN A = 1/TAN C", 5, 0
10110  SET BRUSH 15 : LINE 160, 210; 160, 0
10120  PLOT "A = 90 - C", 185, 190
```

```
10130   PLOT "Worked example", 175, 170
10140   PLOT "If a = 34.5 cm and", 165, 150
10150   PLOT "c = 23.6 cm,", 165, 140
10160   PLOT "solve the triangle.", 165, 130
10170   PLOT "TAN A = a/c", 165, 120
10180   PLOT "TAN A = 34.5/23.6", 165, 110
10190   PLOT "TAN A = 1.462", 165, 100
10200   PLOT "ARCTAN 1.462 = A", 165, 90
10210   SET BRUSH 2 : PLOT "A = 55.63 degs", 175, 80
10220   SET BRUSH 15 : PLOT "C = 90 - 55.63", 175, 70
10230   SET BRUSH 2 : PLOT "C = 34.37 degs", 175, 60
10240   SET BRUSH 15 : PLOT "SIN A = a/b", 175, 50
10250   PLOT "b = a/SIN A", 175, 40
10260   PLOT "b = 34.5/0.825", 175, 30
10270   SET BRUSH 2 : PLOT "b = 41.80 cm", 175, 20
10280   FOR I := 1 TO 200 : NEXT I
10290   SET BRUSH 13 : PLOT "PRESS SPACE-BAR", 175, 10
10300   PLOT "TO CONTINUE", 195, 0
10310   Answer$ := GET$()
10320   Alpha
10330   Beta
10340   Gamma
10350   Alphal
10360   Epsilon
10370   Phi
10380 ENDPROC
10390 PROCEDURE Alpha
10400   SET PAPER 1 : Triangle
10410   Total := 0 : Count := 0
```

```
10420   SET WRITING 1 TO 1, 11; 40, 15
10430   SET WRITING 2 TO 1, 16; 40, 25
10440   LINE 0, 150; 319, 150
10450   SET WRITING 1 : SET PAPER 15
10460   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
10470   Opp := RND(100) + 20
10480   Hyp := Opp + RND(10) + 10
10490   PRINT 1 !, TAB (5); "If a ="; Opp; "cm and b="; Hyp; " then"
10500   PRINT #2 !, TAB (5); "If a ="; Opp; "cm and b ="; Hyp; "cm then"
10510   PRINT 1; TAB (3); "calculate angle A."
10520   PRINT #2, TAB (3); "calculate angle A."
10530   SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for angle A";
10540   PRINT #2 !, TAB (2); "Input your answer for angle A";
10550   SET WRITING 2 : INPUT Angle
10560   PRINT #2, Angle
10570   SET DEG TRUE
10580   X := Opp / Hyp
10590   Angle1 := ATN(X / SQRT(- X * X + 1))
10600   IF ABS(Angle1 - Angle) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 10630
10610   IF ABS(Angle1 - Angle) <  1e-02 THEN PRINT #2, "CORRECT"
10620   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Angle1 - Angle) <  1e-02 THEN 10710
10630   PRINT 2, TAB (2) "No! That is not right,try again"
10640   PRINT #2, TAB (2) "No! That is not right,try again"
10650   FOR I := 1 TO 1000 : NEXT I
10660   CLS 2
10670   Total := Total + 1
10680   IF Total < 3 THEN 10530
10690   GOSUB 10740
10700   GOTO 10400
```

```
10710   Count := Count + 1
10720   IF Count < 4 THEN 10470
10730   GOTO 10830
10740   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
10750   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
10760   PRINT 2 !, TAB (7) "ANGLE A =ArcSin(a/b)"
10770   PRINT #2 !, TAB (7) "ANGLE A =ArcSin(a/b)"
10780   PRINT 2, TAB (2) "ArcSin("; Opp; "/"; Hyp; ")="; Angle1; "degs"
10790   PRINT #2, TAB (2) "ArcSin("; Opp; "/"; Hyp; ")="; Angle1; "degs"
10800   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
10810   Answer$ := GET$()
10820   RETURN
10830 ENDPROC
10840 PROCEDURE Beta
10850   Triangle
10860   Total := 0 : Count := 0
10870   SET WRITING 1 TO 1, 11; 40, 15
10880   SET WRITING 2 TO 1, 16; 40, 25
10890   LINE 0, 150; 319, 150
10900   SET WRITING 1 : SET PAPER 15
10910   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
10920   Opp := RND(100) + 20
10930   Hyp := Opp + RND(10) + 10
10940   PRINT 1 !, TAB (5); "If a ="; Opp; "cm and b ="; Hyp; "cm then"
10950   PRINT #2 !, TAB (5); "If a ="; Opp; "cm and b ="; Hyp; "cm then"
10960   PRINT 1; TAB (3); "calculate angle C."
10970   PRINT #2, TAB (3); "calculate angle C."
10980   SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for angle C";
10990   PRINT #2 !, TAB (2); "Input your answer for angle C";
```

```
11000   SET WRITING 2 : INPUT Angle
11010   PRINT #2, Angle
11020   X := Opp / Hyp
11030   Angle1 := 90 - (ATN(X / SQRT(- X * X + 1)))
11040   IF ABS(Angle1 - Angle) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 11070
11050   IF ABS(Angle1 - Angle) <  1e-02 THEN PRINT #2, "CORRECT"
11060   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Angle1 - Angle) <  1e-02 THEN 11150
11070   PRINT 2, TAB (2) "No! That is not right,try again"
11080   PRINT #2, TAB (2) "No! That is not right,try again"
11090   FOR I := 1 TO 1000 : NEXT I
11100   CLS 2
11110   Total := Total + 1
11120   IF Total < 3 THEN 10980
11130   GOSUB 11180
11140   GOTO 10850
11150   Count := Count + 1
11160   IF Count < 4 THEN 10920
11170   GOTO 11270
11180   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
11190   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
11200   PRINT 2 !, TAB (7) "ANGLE C =ArcCos(a/b)"
11210   PRINT #2 !, TAB (7) "ANGLE C =ArcCos(a/b)"
11220   PRINT 2, TAB (2) "ArcCos("; Opp; "/"; Hyp; ")="; Angle1; "degs"
11230   PRINT #2, TAB (2) "ArcCos("; Opp; "/"; Hyp; ")="; Angle1; "degs"
11240   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
11250   Answer$ := GET$()
11260   RETURN
11270 ENDPROC
11280 PROCEDURE Gamma
```

```
11290  Triangle
11300  Total := 0 : Count := 0
11310  SET WRITING 1 TO 1, 11; 40, 15
11320  SET WRITING 2 TO 1, 16; 40, 25
11330  LINE 0, 150; 319, 150
11340  SET WRITING 1 : SET PAPER 15
11350  SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
11360  Opp := RND(100) + 20
11370  Adj := RND(100) + 10
11380  PRINT 1 !, TAB (5); "If a ="; Opp; "cm and c ="; Adj; "cm then"
11390  PRINT #2 !, TAB (5); "If a ="; Opp; "cm and c ="; Adj; "cm then"
11400  PRINT 1; TAB (3); "calculate angle A."
11410  PRINT #2, TAB (3); "calculate angle A."
11420  SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for angle A";
11430  PRINT #2 !, TAB (2); "Input your answer for angle A";
11440  SET WRITING 2 : INPUT Angle
11450  PRINT #2, Angle
11460  X := Opp / Adj
11470  Angle1 := ATN(X)
11480  IF ABS(Angle1 - Angle) < 1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 11510
11490  IF ABS(Angle1 - Angle) < 1e-02 THEN PRINT #2, "CORRECT"
11500  FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Angle1 - Angle) < 1e-02 THEN 11590
11510  PRINT 2, TAB (2) "No! That is not right,try again"
11520  PRINT #2, TAB (2) "No! That is not right,try again"
11530  FOR I := 1 TO 1000 : NEXT I
11540  CLS 2
11550  Total := Total + 1
11560  IF Total < 3 THEN 11420
11570  GOSUB 11620
```

```
11580   GOTO 11290
11590   Count := Count + 1
11600   IF Count < 4 THEN 11350
11610   GOTO 11710
11620   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
11630   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
11640   PRINT 2 !, TAB (7) "ANGLE A =ArcTan(a/c)"
11650   PRINT #2 !, TAB (7) "ANGLE A =ArcTan(a/c)"
11660   PRINT 2, TAB (2) "ArcTan("; Opp; "/"; Adj; ")="; Angle1; "degs"
11670   PRINT #2, TAB (2) "ArcTan("; Opp; "/"; Adj; ")="; Angle1; "degs"
11680   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
11690   Answer$ := GET$()
11700   RETURN
11710 ENDPROC
11720 PROCEDURE Alpha1
11730   Triangle
11740   Total := 0 : Count := 0
11750   SET WRITING 1 TO 1, 11; 40, 15
11760   SET WRITING 2 TO 1, 16; 40, 25
11770   LINE 0, 150; 319, 150
11780   SET WRITING 1 : SET PAPER 15
11790   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
11800   Opp := RND(100) + 20
11810   Angle := INT(RND(1) * 80) + 1
11820   PRINT 1 !, TAB (4); "If a ="; Opp; "cm and A="; Angle; "degrees then"
11830   PRINT #2 !; TAB (4); "If a ="; Opp; "cm and A="; Angle; "degrees then"
11840   PRINT 1; TAB (3); "calculate side b."
11850   PRINT #2; TAB (3); "calculate side b."
11860   SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for side b";
```

```
11870   PRINT #2 !, TAB (2); "Input your answer for side b";
11880   SET WRITING 2 : INPUT B
11890   PRINT #2, B
11900   SET DEG TRUE
11910   Sideb := Opp / SIN(Angle)
11920   IF ABS(Sideb - B) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 11950
11930   IF ABS(Sideb - B) <  1e-02 THEN PRINT #2, "CORRECT"
11940   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Sideb - B) <  1e-02 THEN 12030
11950   PRINT 2, TAB (2) "No! That is not right,try again"
11960   PRINT #2, TAB (2) "No! That is not right,try again"
11970   FOR I := 1 TO 1000 : NEXT I
11980   CLS 2
11990   Total := Total + 1
12000   IF Total < 3 THEN 11860
12010   GOSUB 12060
12020   GOTO 11730
12030   Count := Count + 1
12040   IF Count < 4 THEN 11800
12050   GOTO 12150
12060   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12070   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12080   PRINT 2 !, TAB (7) "Side b = a/SinA"
12090   PRINT #2 !, TAB (7) "Side b = a/SinA"
12100   PRINT 2, TAB (2) "b ="; Opp; " / Sin"; Angle; " = "; Sideb; "cm"
12110   PRINT #2, TAB (2) "b ="; Opp; " / Sin"; Angle; " = "; Sideb
12120   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
12130   Answer$ := GET$()
12140   RETURN
12150 ENDPROC
```

```
12160 PROCEDURE Epsilon
12170   Triangle
12180   Total := 0 : Count := 0
12190   SET WRITING 1 TO 1, 11; 40, 15
12200   SET WRITING 2 TO 1, 16; 40, 25
12210   LINE 0, 150; 319, 150
12220   SET WRITING 1 : SET PAPER 15
12230   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
12240   Adj := RND(100) + 20
12250   Angle := INT(RND(1) * 80) + 1
12260   PRINT 1 !, TAB (4); "If c ="; Adj; "cm and A="; Angle; "degrees then"
12270   PRINT #2 !; TAB (4); "If c ="; Adj; "cm and A="; Angle; "degrees then"
12280   PRINT 1; TAB (3); "calculate side b."
12290   PRINT #2; TAB (3); "calculate side b."
12300   SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for side b";
12310   PRINT #2 !, TAB (2); "Input your answer for side b";
12320   SET WRITING 2 : INPUT B
12330   PRINT #2, B
12340   SET DEG TRUE
12350   Sideb := Adj / COS(Angle)
12360   IF ABS(Sideb - B) < 1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 12390
12370   IF ABS(Sideb - B) < 1e-02 THEN PRINT #2, "CORRECT"
12380   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Sideb - B) < 1e-02 THEN 12470
12390   PRINT 2, TAB (2) "No! That is not right,try again"
12400   PRINT #2, TAB (2) "No! That is not right,try again"
12410   FOR I := 1 TO 1000 : NEXT I
12420   CLS 2
12430   Total := Total + 1
12440   IF Total < 3 THEN 12300
```

```
12450   GOSUB 12500
12460   GOTO 12170
12470   Count := Count + 1
12480   IF Count < 4 THEN 12240
12490   GOTO 12590
12500   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12510   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12520   PRINT 2 !, TAB (7) "Side b = c/CosA"
12530   PRINT #2 !, TAB (7) "Side b = c/CosA"
12540   PRINT 2, TAB (2) "b ="; Adj; " / Cos"; Angle; " = "; Sideb; "cm"
12550   PRINT #2, TAB (2) "b ="; Adj; " / Cos"; Angle; " = "; Sideb
12560   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
12570   Answer$ := GET$()
12580   RETURN
12590 ENDPROC
12600 PROCEDURE Phi
12610   Triangle
12620   Total := 0 : Count := 0
12630   SET WRITING 1 TO 1, 11; 40, 15
12640   SET WRITING 2 TO 1, 16; 40, 25
12650   LINE 0, 150; 319, 150
12660   SET WRITING 1 : SET PAPER 15
12670   SET WRITING 1 : CLS : SET WRITING 2 : CLS : SET PEN 6
12680   Opp := RND(100) + 20
12690   Angle := INT(RND(1) * 80) + 1
12700   PRINT 1 !, TAB (4); "If c ="; Opp; "cm and C="; Angle; "degrees then"
12710   PRINT #2 !; TAB (4); "If c ="; Opp; "cm and C="; Angle; "degrees then"
12720   PRINT 1; TAB (3); "calculate side a."
12730   PRINT #2; TAB (3); "calculate side a."
```

```
12740   SET CURPOS 0, 1 : PRINT 2 !, TAB (2); "Input your answer for side a";
12750   PRINT #2 !, TAB (2); "Input your answer for side a";
12760   SET WRITING 2 : INPUT A
12770   PRINT #2, A
12780   SET DEG TRUE
12790   Sidea := Opp / TAN(Angle)
12800   IF ABS(Sidea - A) <  1e-02 THEN SET BRUSH 1 : PLOT "CORRECT", 80, 10 SIZE 3 ELSE 12830
12810   IF ABS(Sidea - A) <  1e-02 THEN PRINT #2, "CORRECT"
12820   FOR I := 1 TO 2000 : NEXT I : CLS 2 : IF ABS(Sidea - A) <  1e-02 THEN 12910
12830   PRINT 2, TAB (2) "No! That is not right,try again"
12840   PRINT #2, TAB (2) "No! That is not right,try again"
12850   FOR I := 1 TO 1000 : NEXT I
12860   CLS 2
12870   Total := Total + 1
12880   IF Total < 3 THEN 12740
12890   GOSUB 12940
12900   GOTO 12610
12910   Count := Count + 1
12920   IF Count < 4 THEN 12680
12930   GOTO 13030
12940   SET CURPOS 0, 1 : PRINT 2 ! TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12950   PRINT #2 !, TAB (1) "THIS IS THE CORRECT METHOD OF SOLUTION"
12960   PRINT 2 !, TAB (7) "Side a = c/TanC"
12970   PRINT #2 !, TAB (7) "Side a = c/TanC"
12980   PRINT 2, TAB (2) "a ="; Opp; " / tan"; Angle; " = "; Sidea; "cm"
12990   PRINT #2, TAB (2) "a ="; Opp; " / tan"; Angle; " = "; Sidea
13000   PRINT 2 !, TAB (6); "PRESS SPACE-BAR TO CONTINUE"
13010   Answer$ := GET$()
13020   RETURN
```

```
13030   SET WRITING 0
13040 ENDPROC
13050 PROCEDURE Triangle
13060   SET PAPER 1 : SET BORDER 10 : CLG
13070   SET BRUSH 15 : AREA 10, 170; 100, 230; 100, 170 STYLE 3
13080   LINE 90, 170; 90, 180; 100, 180
13090   PLOT "A", 5, 160 : PLOT "B", 105, 160 : PLOT "C", 105, 230
13100   SET BRUSH 10 : PLOT "a", 105, 195 : PLOT "b", 45, 205 : PLOT "c", 50, 160
13110   PLOT "Solve the problem.", 155, 195
13120 ENDPROC
```

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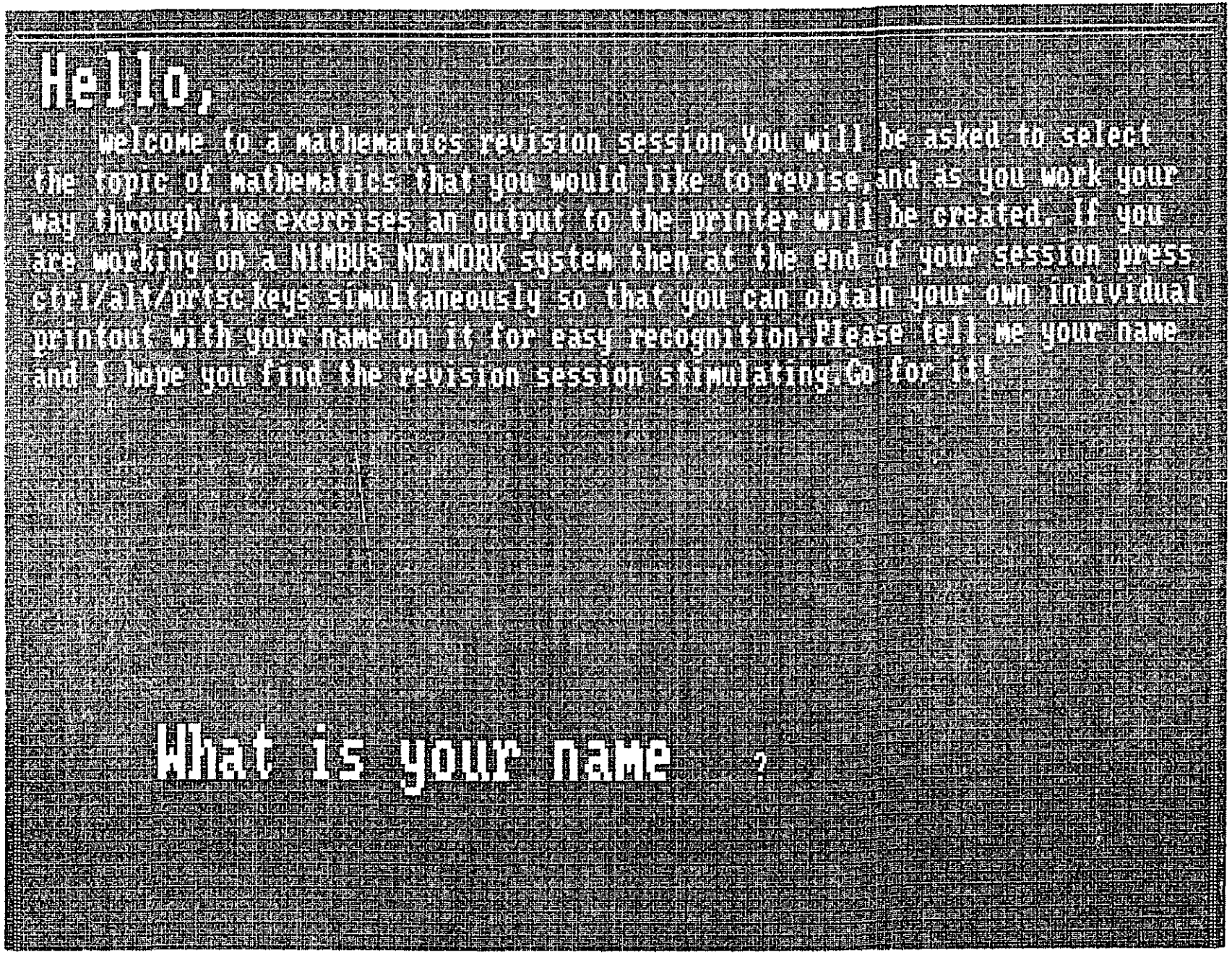
APPENDIX

SCREEN DUMPS OF SOME OF THE DIAGRAMS AND GRAPHICS.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY
M.Sc. COMPUTER EDUCATION
(C) R.E.FORD
CENTRE FOR ADVANCEMENT OF MATHEMATICAL
EDUCATION IN TECHNOLOGY


Hello,
Welcome to a Mathematics revision session. You will be asked to select the topic of Mathematics that you would like to revise, and as you work your way through the exercises an output to the printer will be created. If you are working on a NIMBUS NETWORK system then at the end of your session press ctrl/alt/prtsc keys simultaneously so that you can obtain your own individual printout with your name on it for easy recognition. Please tell me your name and I hope you find the revision session stimulating. Go for it!
What is your name ?

MENU
ENGINEERING MATHEMATICS

1	TRIGONOMETRY	F LEVEL
2	GRAPHS	F&M LEVEL
3	3 DIMENSIONAL TRIGONOMETRY	F&M LEVEL
4	PROPERTIES OF THE CIRCLE	F LEVEL
5	END SESSION	

SELECT THE NUMBER OF YOUR CHOICE

TRIGONOMETRY
B LEVEL

INTRODUCTION TO TRIGONOMETRY
THE RIGHT-ANGLED TRIANGLE

SINE A = a/b
COSINE A = c/b
TANGENT A = a/c

SINE C = c/b
COSINE C = a/b
TANGENT C = c/a

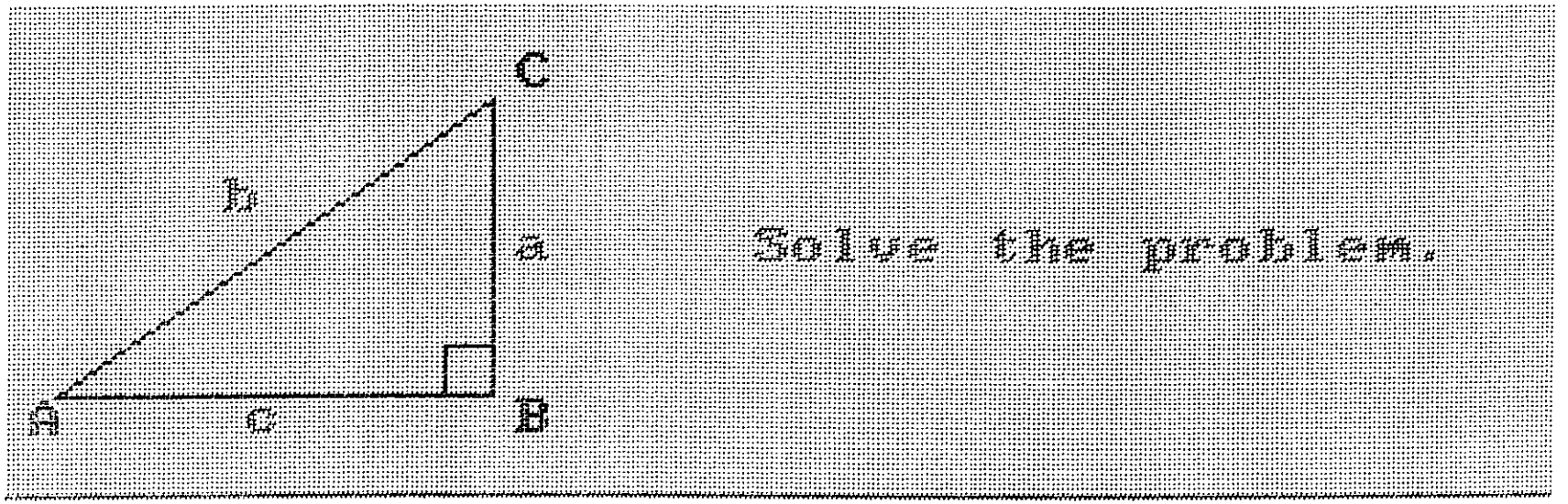
From the above it can be seen that
SIN A = COS C
COS A = SIN C

A = 90 - C

Worked example

If a = 34.5 cm and c = 23.6 cm, solve the triangle.

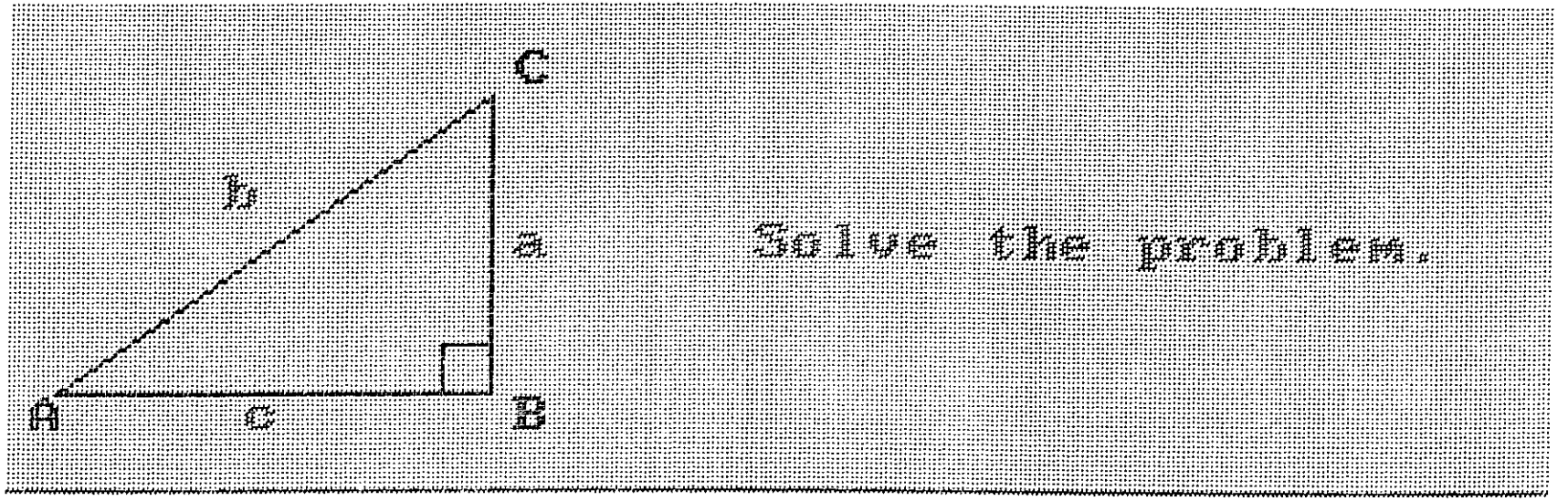
TAN A = a/c
TAN A = 34.5/23.6
TAN A = 1.462
ARCTAN 1.462 = A
A = 55.63 degs
C = 90 - 55.63
C = 34.37 degs
SIN A = a/b
b = a/SIN A
b = 34.5/0.825
b = 41.80 cm



Solve the problem.

If a = 104 cm and b= 123 then calculate angle A.

Input your answer for angle A?_

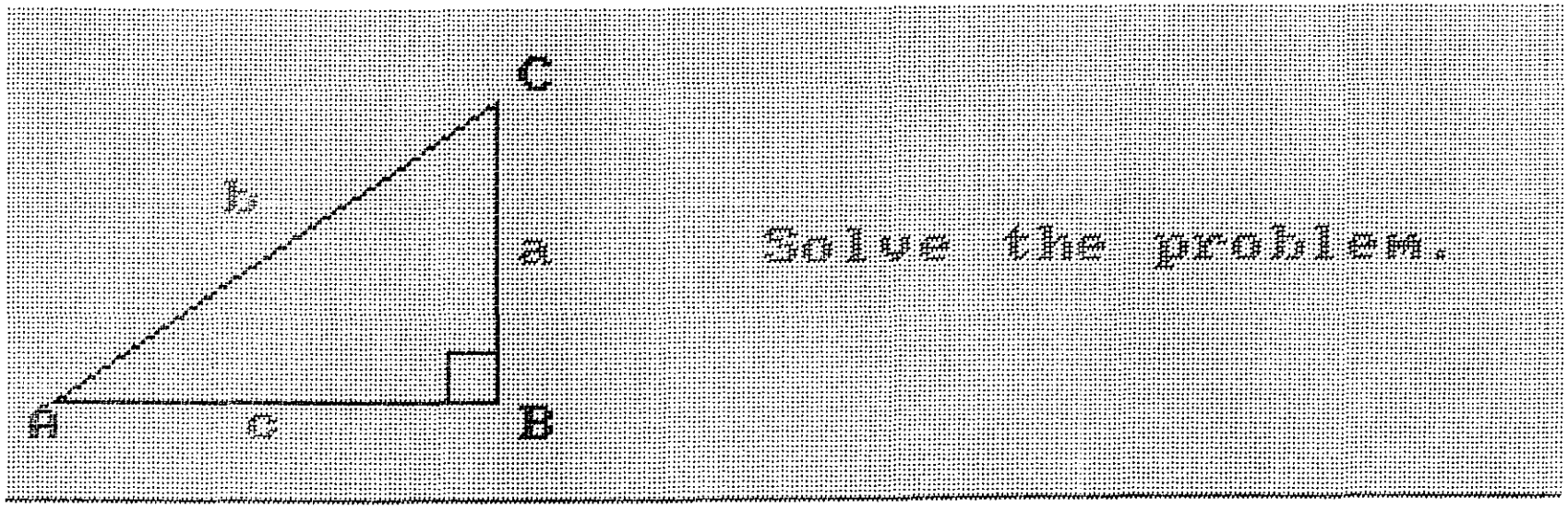


If a = 104 cm and b= 123 then calculate angle A.

THIS IS THE CORRECT METHOD OF SOLUTION

ANGLE A =ArcSin(a/b)
ArcSin(104 / 123)= 57.72861 degs

PRESS SPACE-BAR TO CONTINUE



Solve the problem.

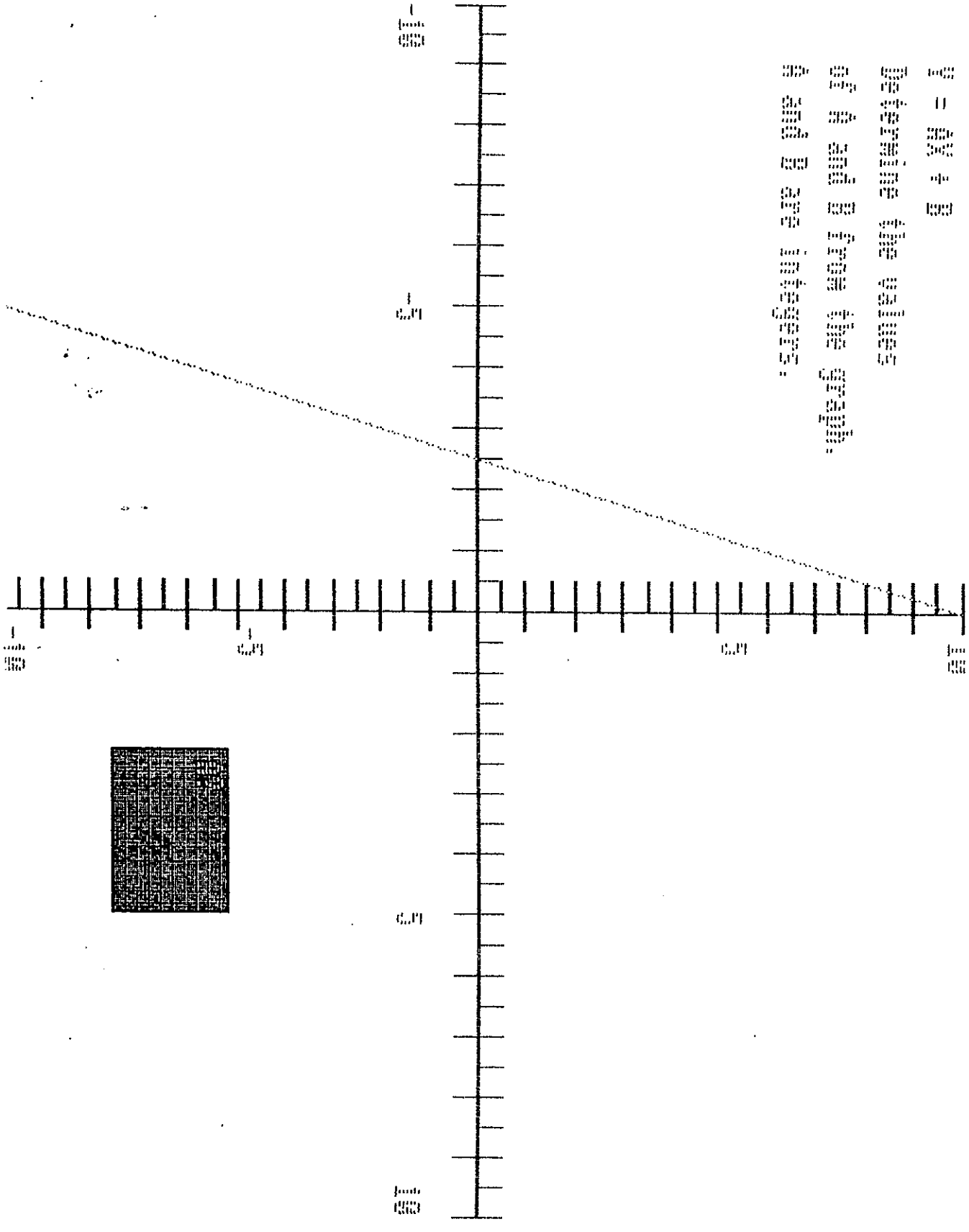
If a = 24 cm and b= 39 then calculate angle A.

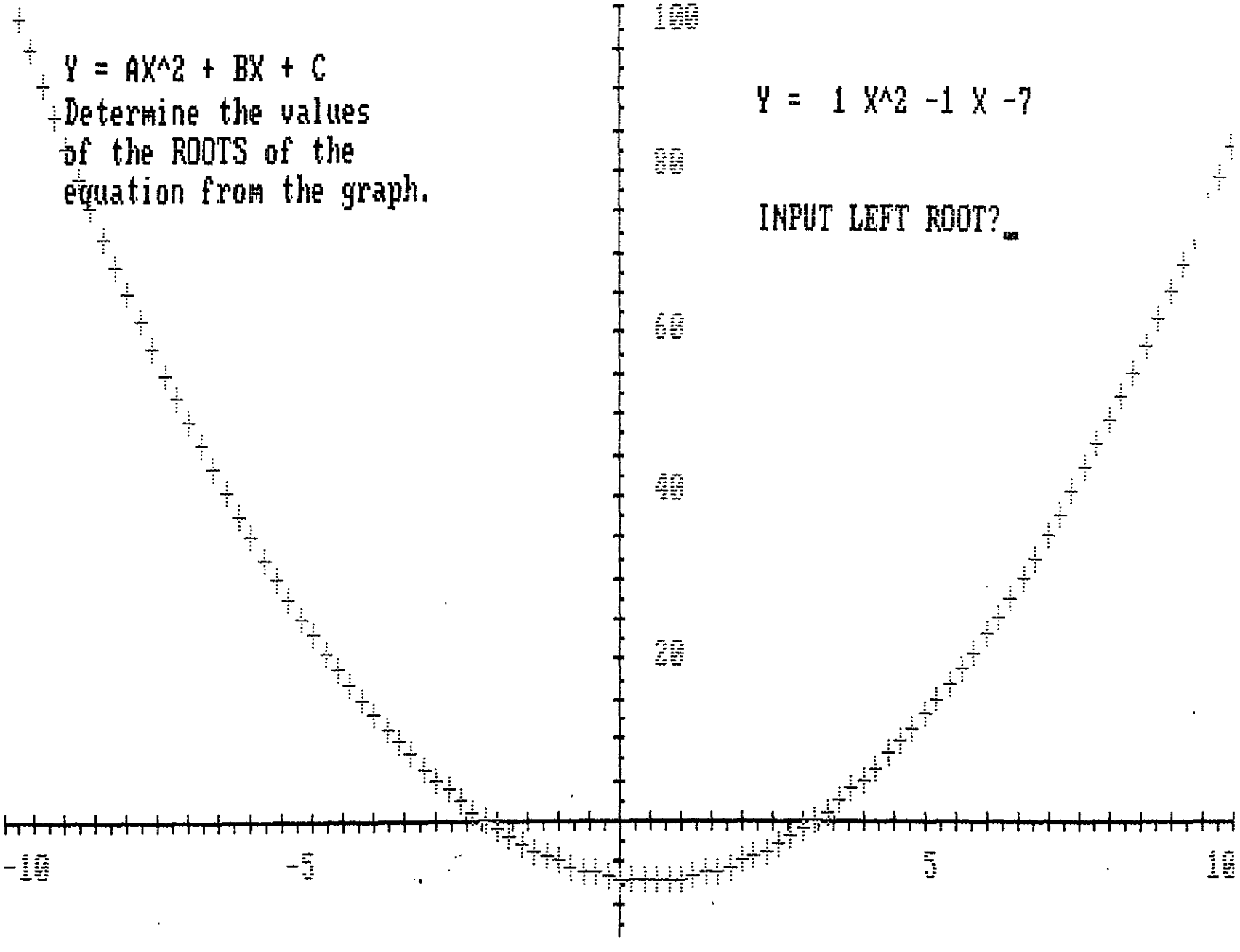
Input your answer for angle A?37.979

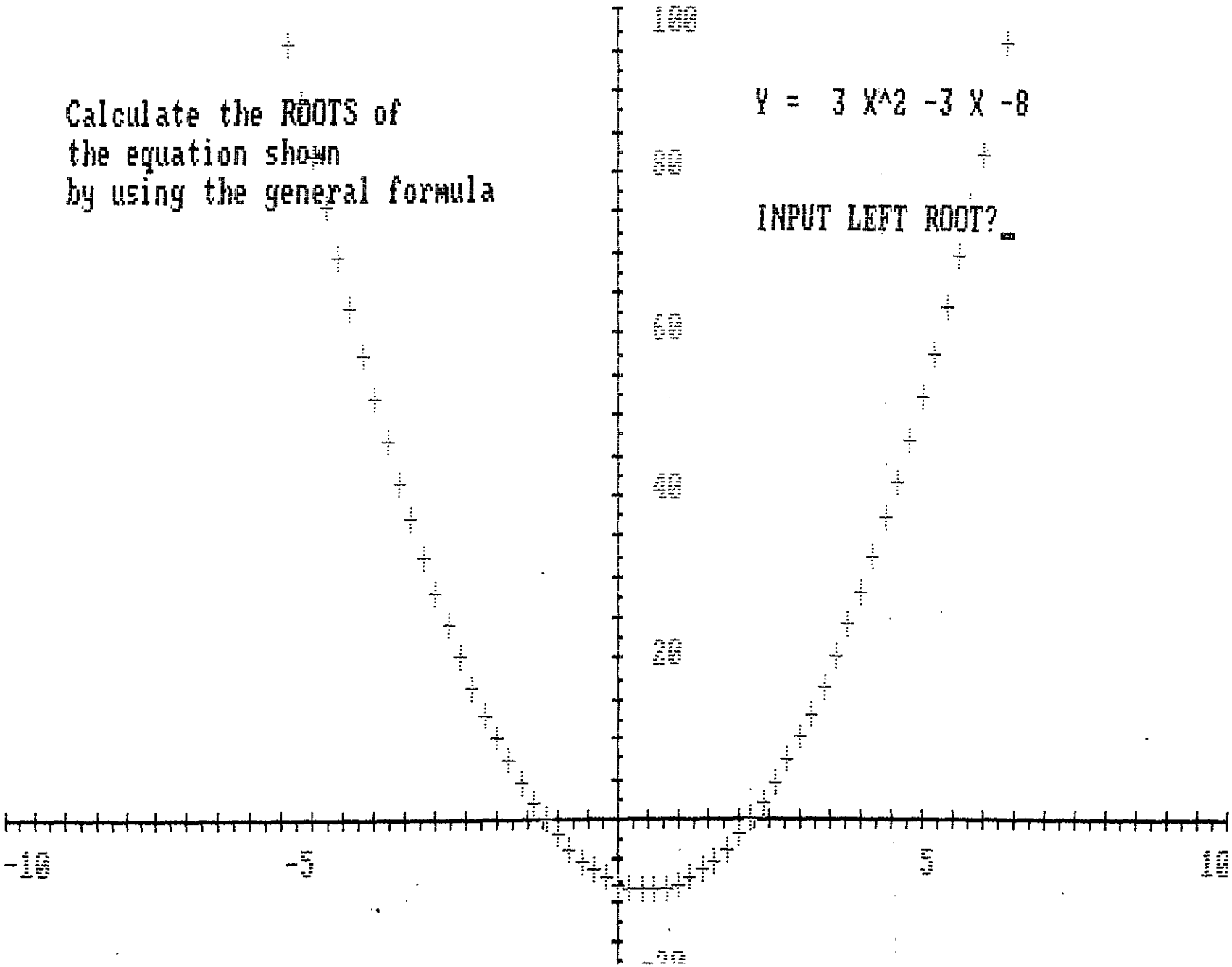
CORRECT

GRAPHS
R & N LEVEL

```
                    GRAPHS

 (1) STRAIGHT LINE GRAPHS:  Y = AX+B

 (2) QUADRATIC GRAPHS:  Y=AX^2+BX+C


 CHOOSE A NUMBER AND PRESS ENTER KEY.

    YOU WILL NEED A CALCULATOR.

    ?_
```




Y = AX^2 + BX + C
Determine the values of the ROOTS of the equation from the graph.
Y = 1 X^2 -1 X -7
INPUT LEFT ROOT?
100
80
60
40
20
-10
-5
5
10


Calculate the ROOTS of
the equation shown
by using the general formula
Y = 3 X^2 -3 X -8
INPUT LEFT ROOT?
100
80
60
40
20
-10
-5
5
10

3-DIMENSIONAL TRIGONOMETRY

F & N LEVEL

This set of exercises is to help you understand some applications of ENGINEERING TRIGONOMETRY. The computer will create questions for you to answer. You will need a CALCULATOR. The diagrams are for revision purposes.

PRESS ANY KEY TO CONTINUE

THE ANGLE BETWEEN LINE AC AND PLANE DEFG IS 0

A

POINT A IS PROJECTED DOWN TO POINT B ON PLANE DEFG

D

E

PLANE DEFG

B

C

G

F

PRESS ANY KEY TO CONTINUE

THE ANGLE BETWEEN TWO INTERSECTING PLANES

THE ANGLE BETWEEN THE TWO PLANES IS ANGLE HIJ SHOWN AS D

PRESS ANY KEY TO CONTINUE

LENGTHS AND AREAS ON AN INCLINED PLANE

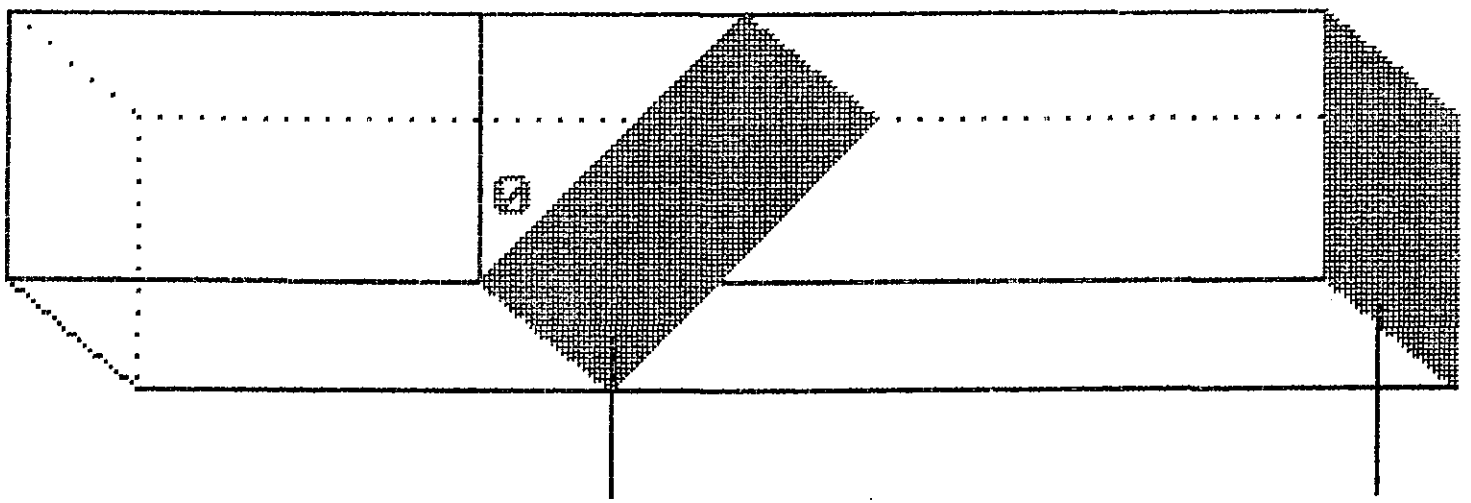
$$\cos\theta = \frac{DE}{DC}$$

$$\text{AREA ABED} = \frac{\text{AREA DEC}}{\cos\theta}$$

PRESS ANY KEY TO CONTINUE

THE OBLIQUE AREA OF A PRISM

$$\text{OBLIQUE AREA} = \frac{\text{CROSS-SECTIONAL AREA}}{\cos \theta}$$



OBLIQUE AREA. CROSS-SECT AREA.

PRESS ANY KEY TO CONTINUE

EXAMPLE

CYLINDRICAL PRISM

OBLIQUE AREA = PI*RAD^2/COS A

IF THE RADIUS IS = 84 MM
AND THE ANGLE IS = 39 DEGS

THEN CALCULATE THE OBLIQUE AREA

INPUT YOUR ANSWER ?28523.699

CORRECT

MEASUREMENT OF EXTERNAL DOVETAIL BY THE USE OF PRECISION ROLLERS

REF = M - 2(d/2+X)

tanA=d/2X : 2X=d/tanA : 2X=d×cotanA

REF = M - d(1+cotanA)

PRESS ANY KEY TO CONTINUE

EXAMPLES

REF = M - d(1+Cotanθ)

IF THE READING M IS 161 mm,

THE DIAMETER, d=25 mm

AND THE ANGLE, θ=30 deg

THEN CALCULATE THE VALUE OF REF

INPUT YOUR ANSWER?32.698

CORRECT

```
        REF = M - d(1+cotanA)

        IF THE READING M IS 123 mm,

        THE DIAMTER, d=25 mm

        AND THE ANGLE, A=30 deg

    THEN CALCULATE THE VALUE OF REF

      INPUT YOUR ANSWER?2
NO! That is NOT right, try again

      INPUT YOUR ANSWER?2
NO! That is NOT right, try again

      INPUT YOUR ANSWER?2
NO! That is NOT right, try again

THIS IS THE CORRECT METHOD OF SOLUTION

        REF = M - d(1+cotanA)

      123 -25(1+cotan30)= 54.69873 mm
```

TERMINOLOGY AND PROPERTIES OF THE CIRCLE

PRESS SPACE-BAR
TO CONTINUE

The distance from the centre to the curve, OA, is called the RADIUS, r, of the circle.

Any straight line passing through the centre and touching the circumference at each end as BC does is called the DIAMETER, d. The diameter is twice the length of the radius, d=2r.

The boundary of a circle, that is the perimeter, is called the CIRCUMFERENCE, and is equal to the constant π, 3.142 to three decimal places.

A TANGENT to a circle is a straight line which meets the circle at one point, i.e. it is a tangent to the circle. It radius OA is drawn then AO is a RIGHT-ANGLE.

PRESS SPACE-BAR TO CONTINUE.

The shaded portion OXY is called a SECTOR.

If the sector is less than a semi-circle it is a MINOR SECTOR. If larger than a semi-circle it is a MAJOR SECTOR.

The line OU is a CHORD.

The shaded portion UU is a SEGMENT.

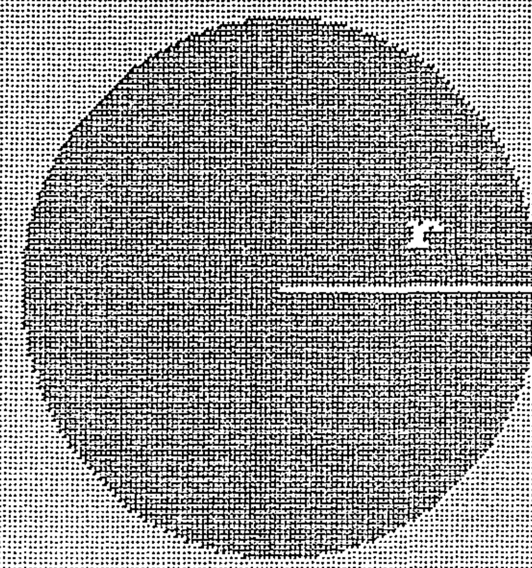
The shortest distance between U and U along the circumference is called the MINOR ARC. The remaining part of the circumference is the MAJOR ARC.

An angle can be measured in DEGREES or RADIANS. A RADIAN is defined as the angle formed at the centre of a circle by an ARC equal in length to the RADIUS.

θ = 1 radian = 57.2 degs.

2πΠ radians = 360 degs.

PRESS SPACE BAR TO CONTINUE



Area of a circle = $PI \times r^2$

or $\frac{PI \times d^2}{4}$

Have a go at the following questions.

PRESS SPACE BAR TO CONTINUE

The disc accompanying this Thesis is held with the archive copy in the cage on Level 2. Please enquire in the Information Office on Level 3 if you wish to borrow it.