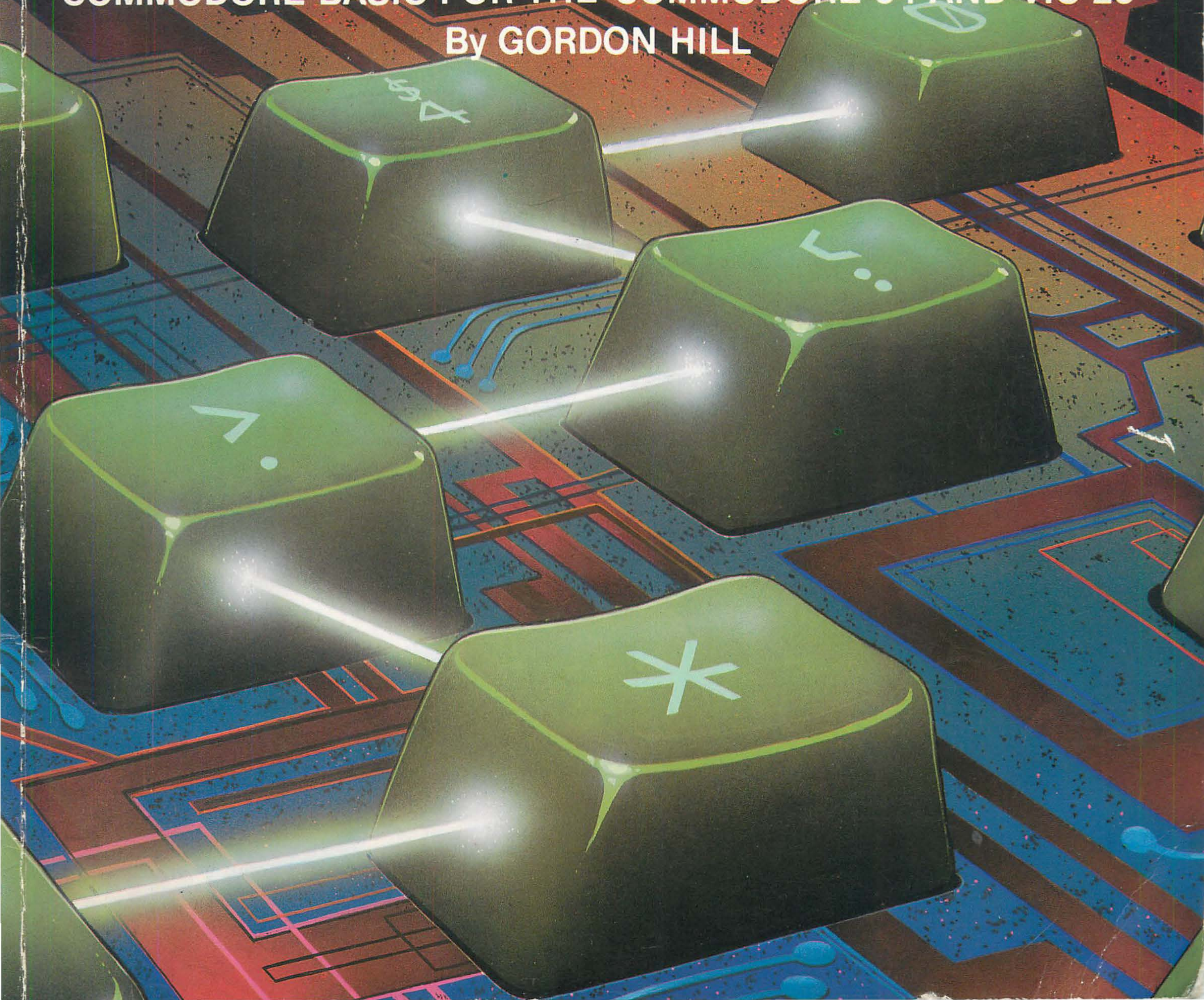
THE commodore PROGRAMMER'S ROUTE MAP

COMMODORE BASIC FOR THE COMMODORE 64 AND VIC 20

By GORDON HILL



The Commodore Programmer's Route Map for the Commodore 64 and VIC 2Ø Commodore Basic

Gordon Hill

W. Foulsham & Co. Ltd.
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PREFACE

There is now a wide variety of books available for the CBM home computers, but few of them really get stuck into the practical problems that afflict any programmer once he is past the beginner stage. This book can't do the work for you, but it can help you get things working in several ways.

Right at the start when you begin to use your machine with the help of your manual, you will often find an explanation difficult to follow. Reference to this book may help by giving another way of looking at things.

In Section 1 it gives you an idea how good programmers – professionals and amateurs – go about designing programs, and the types of problems they tend to run in to.

Section 2 will help you with BASIC language problems, how to get the best use from it and what to look for if it fails to work the way you wanted it to. Examples for most of the keywords help you to understand their purpose or can be used as part of your program.

Section 3 gives you a number of working routines that you can include in your programs, or you can use the ideas to write similar routines of your own.

The rest of the book contains useful reference information missing from or not easy to find in the manual that comes with your machine.

Commodore BASIC, as used in the VIC 20 and CBM 64 is not very friendly in comparison with some other dialects around and in comparison with the all-singing – all-dancing BASICs used by many home computers. For instance, while CBM BASIC has about 60 statements and functions, some other machines have 100 or more. Many regard it as primitive or even archaic (it dates from about 1977!). Where else do you find a computer like the CBM 64 that requires half a dozen five figure **POKE**s to play a single note? But that's not the whole story. The limited vocabulary means a more compact interpreter (meaning more memory for your program) and often more efficient code – provided you understand the subtleties and nuances of the language.

Programmers who have used other machines will find Section 2 a rapid reference to the particular qualities of this BASIC and the examples here and in Section 3 illustrate many ways in which the language can be used to overcome its apparent limitations.

Your computer is a very powerful and versatile machine and this book will help you to get the best results from it.

CONTENTS

SECTION 1 INTRODUCTION

The Aim of the Book

This book is intended for those users or owners of a Commodore VIC 2Ø or CBM 64 who aim to be serious programmers and would like a more in-depth guide than that provided by the user handbook. It can be used in conjunction with the handbook, or by itself for those who are already acquainted with BASIC. Those who have spent some time programming in PET or VIC BASIC may still find that this book allows them to make fuller use of the facilities of the language. Converts from other BASICs will find that the detailed descriptions of Commodore BASIC functions given here provide the means for a rapid transition.

The book contains detailed descriptions of all BASIC functions in Section 2, and some general information and useful routines in Section 3. The detailed descriptions are intended to overcome the frustration felt by programmers who know where a program is going wrong through normal debugging methods, but are unsure exactly how the BASIC functions operate. For instance, many programmers have been held up for hours on the bug in the **INPUT** (q.v.) function. Section 3 gives a collection of commonly required subroutines, mostly built into programs, which can speed up development of a program either by the direct incorporation of routines into your program or by showing ways in which problems can be tackled.

Hardware is not dealt with in this book. However, one of the major plus points for the VIC 2Ø and CBM 64 is the ease with which Commodore supplied or compatible accessories can be attached, and the way in which they operate without either affecting the operating system or taking away memory from the BASIC RAM area. Most users will therefore be able to attach and use these for simple applications such as **LOAD**ing, **SAVE**ing and **PRINT**ing without too much difficulty. Of course, for more sophisticated applications and many disk applications, a deeper understanding of the peripheral operations is required. These are all explained in the relevant manuals, but are not easy for many people to understand and require careful study. For this reason, I have explained certain aspects of file handling at some length at the end of this section.

Writing in BASIC

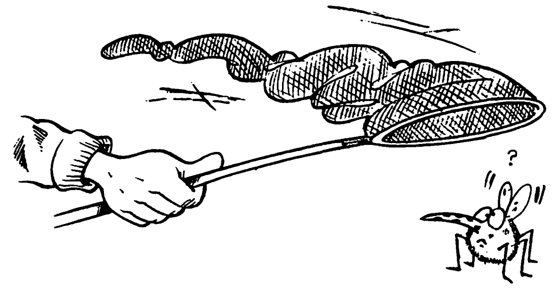
Writing short programs in BASIC is not difficult with the aid of the guide which comes with the computer, or other introductions to the language. However, writing more complex programs speedily and efficiently is more difficult than most people realise until they have tried it themselves. Hours can go by like minutes when debugging programs.

There is no easy solution to this (that's why trained professional programmers are so well paid), but it is very easy to ignore the problem until much time has been wasted. Even professional programmers working on large software projects have fallen into the trap of believing that the programs they have undertaken would be easier to write than they in fact turned out to be, causing expensive disasters.

This problem of writing large and complex programs was not realised until about 15 years ago because before that, most computer hardware was not powerful enough to develop really sophisticated programs. At that time the largest computer available to me at Edinburgh was the University Atlas which cost (as I recall) several hundred thousand pounds and had only 64 kbytes of main memory! The only 'micro' we had was an Olivetti P1Ø1 which was driven by an electric motor like the old fashioned calculators you may have read about. Then, in the late sixties, as powerful computers began to become available to more and more people, it became possible to create complex systems which could only have been dreamed about previously. Few people foresaw the problems of complex software and this led to the software crisis of the sixties when many sophisticated systems proved much more difficult to create than expected, or failed altogether.

To understand why this happened and why it will also happen to your programs, unless you take due precautions, think of a program of 1ØØ lines. You can probably completely understand what you have written and can go almost at once to the piece of code that carries out a given task. To write two similar programs of 1ØØ lines each will obviously take about twice as long as writing one. To write a program of 2ØØ lines combining two 1ØØ-line programs requires not only the writing of the two modules but also the process of joining up the code and ensuring that the two functions do not interfere. In addition, it becomes more difficult for you to remember exactly what you have done and where.

To put it another way, for every line of code you write there is a probability (perhaps 1% for each line in a 1ØØ-line program) of it interacting undesirably with another line of code in the program (i.e. causing a bug). The larger the program, the more chance there is of this (perhaps 3% for each line in a 2ØØ-line program etc), until one reaches the stage where the creation of a new line is almost bound to introduce a bug somewhere else. Worse still, the changing of a line somewhere to cure a bug will create one or more different bugs elsewhere in the system, leaving a situation where a program can never be made to work properly. This problem requires the use of special design methods to minimise the interaction between different parts of the program.



You will probably think that all this doesn't apply to you and that you will just be careful not to make mistakes. Well, don't forget I told you so!

To write really complex programs requires a knowledge of design methods beyond the scope of this book, but a methodical approach following a few common sense ground rules will serve well for the average 100- to 200-line program and will pave the way for more complex professional type of programming later. Design and procedural suggestions are as follows.

1. Before switching on the machine or opening a BASIC manual, work out what you want to do and write it down in pencil on any handy piece of paper. Check it over to see if all your required features are present, but resist the temptation to add features that can be added later after the initial program has been tested out.

Then work out the steps you will need to take to do it, also in pencil. Unless you are possessed of a very logical mind and have a clear idea of what you want to do before you start, you will find yourself making much use of the rubber; hence the suggestion that you design in pencil. However keen you are to get on with the coding, remember that it is much easier to play about with your ideas in pencil than to amend reams of code, particularly if you don't have a printer. (For meaning of code as used in computer terms see the Glossary in Section 4).

If you want to check out a particular machine function – perhaps to time nested **FOR** loops – then by all means write a program directly onto the machine, but don't be tempted to do serious work this way.

2. When you have worked out your ideas, make up some code (i.e. a series of BASIC statements) to do it in the simplest possible way, allowing for non-essential options to be added later, and don't worry too much about sound and colour. Take particular care to get the code right on paper before typing it in, particularly if you don't have a printer.

3. Type the code into your machine, **SAVE** it and try it. If (or in most cases when!) it doesn't work, first check that your program has been typed in correctly and then that it follows the logic of your design by checking it line by line. As you make corrections on the machine, mark them on your program sheet so that you know exactly where you stand, or periodically produce a listing on your printer. Check any BASIC statements you are doubtful about under the appropriate heading in this book.

4. If the program still doesn't work and you cannot see anything obviously wrong with it, try a process of elimination by using a toolkit (see below) or by placing **STOP**s or **PRINT**s at various places in the program and using **CONT** to continue the program from **STOP** to **STOP**. This will allow you to follow the path the program has taken and at each **STOP** you can

check all variables to see if they have the values you expect. It is worthwhile performing a "dry run" to see exactly what the variables ought to be at any given point in the program, by working manually through the BASIC, otherwise it is easy to convince yourself that the variables are what you expect simply because they look reasonable.

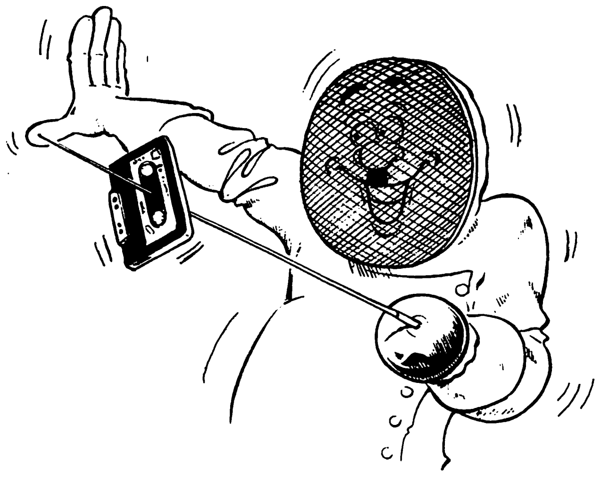
```
For example: 1Ø A=1:B=2
             2Ø C=A+B
             25 STOP
             3Ø D=A*B
```

```
when STOP is reached ?A should give 1
                     ?B should give 2
                     ?C should give 3
and if the program has run for the first time:
                     ?D should give Ø
```

D, of course, should be zero because we have not yet set it. However, a very common problem that arises in mid program is that variables that should have been, say, zero have been set to another value elsewhere in the program. So be careful not to assume it is zero until you have checked it.

Remember that as soon as you change the program, even just by placing the cursor on a program line and pressing <RETURN>, all values are lost (become Ø), strings are cleared and CONT is disabled.

The use of a toolkit, mentioned above, can simplify coding and debugging in a number of ways such as automatic renumbering of lines, tracing the progress of a program by displaying the line numbers on the screen, explaining the 'syntax error' in more detail, single-stepping the program line by line and dumping all variables to the screen. Your local dealer will have details of toolkits available for program development. Although useful, a toolkit will not compensate for poor program design.



5. Once you have confidence that your program is working as it should, then proceed to add colours and sound as required and tidy up or rearrange the screen. A thorough program check is now in order, using the program in as many ways as you can imagine, including invalid commands or replies. If possible get someone else to run through it as well. This person need have no knowledge of programming and can be a friend or someone in the family who would like to try out your program in the same way that arcade games are used by people with no knowledge at all about programming. When he has finished, be prepared to accept constructive criticism with a good grace, even if some of it is not in your opinion valid, otherwise you may not get the same help again!

At this point you will have discovered the "wouldn't it be nice if" syndrome. Make a list of all the nice goodies you would like in your program and select the ones you will use. Don't choose any that involve much rewriting of code already produced – this probably means that your original design was incompatible with the items you are thinking of adding, and avoid those which seem complicated or vaguely defined. Also, if you intend to try to sell your software, be very careful before adding extra pieces of accessory hardware to your machine because your program requires them. These extras will limit your marketplace. If you decide that some of the features you want require extensive modification of the existing program, the best course is usually to throw the program away and start again, perhaps using some of the routines from your old program again. Your efforts will not have been wasted because you will have learned a lot about design and coding, and will be less likely to make the same mistakes again.

Programming Hints

1. If possible (i.e. if sufficient memory exists – see below) use any variable for one purpose only. This reduces the possibility of a variable being set to an unexpected value for one part of the program while being used for another. It also makes debugging a lot easier as values set up throughout the program are not overwritten by other routines.

Space occupied by variables is as follows:

Integers e.g. X%	2 bytes each
Decimal numbers e.g. X	5 bytes each
Strings e.g. X$	1 byte per char. + 3
Arrays.............	as above for each element, + 5, + 2 per dimension

With only 2 bytes available for integers, the values are restricted to between 32767 and -32768. Attempting to exceed these limnits will lead to an ILLEGAL QUANTITY ERROR.

2. Use **REM** statements wherever possible to make the program readable and to record the purpose of each variable.

3. Use only one or two character variable identifiers e.g. AB, A1, AB%, AB$, AB$(X), AC%(D1%,D2%). VIC64 BASIC recognises only the first two characters but does not give an error if more than two are used. Thus BLACK and BLUE will be treated by BASIC as if they were the same identifier BL. Unfortunately, this means that the variables cannot easily be given meaningful names, which makes the code difficult to read. Hence, it is all the more important to use **REM** statements to explain what each variable does. One particularly frustrating problem that can occur, happens when a BASIC keyword is accidentally incorporated in a variable name. NOTE for instance will be interpreted as NOT E, the result of which is usually a syntax error on what appears to be a perfectly good line.

4. Number lines in multiples of 1Ø and make extensive use of subroutines numbered well apart from each other. This makes changing the program much easier.

Arithmetic

Arithmetic in BASIC is very versatile and easy to use, following normal mathematical rules. The meanings of such expressions as A+B, A-B, A*B/C are obvious and for more complex expressions, the order of precedence of operators is ^ (power of) * / + – < > . As an example, the expression A+B*C ^ 2 will be evaluated by squaring C, multiplying that by B and then adding A. Changing the order of precedence is easily achieved by using brackets e.g. (A+B*C) ^ 2 will be evaluated by multiplying B by C, adding A and then squaring the result. For use of < and > as operators see below under 'Comparisons'.

Conventional arithmetic can take place on one of two variable types. The default type – the one normally used – is an ordinary decimal floating point number. If a % sign is added to the variable name, this becomes an integer type with no figures after the decimal point (e.g. AB%). Note that in Commodore BASIC AB% is a totally different variable from AB or AB$. You can use all three in your program without any risk of them conflicting except through use of the wrong type! Although, ideally, you should use integers for indexing of arrays or **FOR/NEXT** loops etc, in practice it is not possible on the CBM 64 or VIC 2Ø. Arithmetic is actually slower using integers, as the interpreter converts integers to floating point numbers before processing them and then truncates them to integer form again! All you save is variable space (see above). However, if you decide to use a compiler to speed things up, this will benefit greatly from the inclusion of integer (%) variables wherever possible.

Although not arithmetic, strings can be "added" which have the effect of concatenating them (running them together) e.g "J" + "OHN" will give "JOHN":

```
    PRINT "J"+"OHN"
```

prints JOHN as does

```
    PRINT A$+B$
```

where A$ contains "J" and B$ "OHN"

Comparisons

Six comparisons are available:

Greater than	>
Less than	<
Equal to	=
Not equal to	<>
Greater than or equal to	>=
Less than or equal to	<=

Their meaning is obvious for numerics, but they can also be used for strings which are compared character by character, the test being performed on the **ASCII** (see Glossary, Section 4) value of the character concerned, so that words, for instance, are compared as they might be when consulting a dictionary.

e.g. ABC comes before ABCD
ABCD comes before ABD

Unlike some versions of BASIC, Commodore BASIC supports boolean algebra beyond the usual AND OR NOT combinations. For the uninitiated this can lead to some strange looking program lines e.g.

```
    C=(A>1)
```

gives –1 if A is greater than 1, or Ø if A is less than or equal to 1 and similarly for the other comparisons. In all cases –1 represents "true" and Ø represents false.

```
    A=A+(A>1Ø)
```

will reduce A by one unless it has reached 1Ø. The brackets are important as otherwise the "+" will happen first, leaving A as –1 or Ø after the first operation of the line, depending on A's starting value.

```
    FOR X=1 TO 2Ø
    A$=LEFT$(A$,LEN(A$)+
        (LEN(A$)>1Ø))
    NEXT X
```

will truncate string A$ by removing 2Ø characters but will not allow the string to drop below 1Ø characters.

```
    PRINT CHR$(NR+48-(NR>9)*7)
```

will print any number between Ø and 15 as its hex character (e.g. 1 prints "1" and 15 prints "F").

File handling

One area of program writing that seems to cause more confusion than any other – at least for beginners – is that of file handling.

In essence, there are three types of file that you can use on most microcomputers. (There are more types on larger computers.) They are:

Program files
Serial data files
Random Access data files

Program files are those you use every time you save a BASIC program to casssette tape or disk. All the information is saved in line number order, and any ancillary information you need to store – such as names and addresses – could be kept in **DATA** statements, often at the end of the program.

The great advantage of a program file is that it is taken care of automatically by the computer operating system, with the **LOAD**, **SAVE** and **VERIFY** functions. Once the program is working, there is very little that can go wrong.

On the other hand, there are two very serious limitations. Firstly, program data files are very inflexible; you can't enter any of the stored information while the program is running. If you want to amend, for example, an address or telephone number, you have to **STOP** the program, **LIST** it to find the appropriate **DATA** statement (not always an easy task!) and edit the offending program line.

The problem is even worse if you need to add information to the **DATA** statements, because then you need also to change the part of the program that **READ**s the **DATA** – often a **FOR/NEXT** loop.

The other limitation is memory size. You can include sufficient information to fill the memory space available between the end of your BASIC program and the top of RAM. This might represent a limit of perhaps 1ØØ-15Ø names, addresses and telephone numbers (on a CBM 64) – none of which, remember, can be changed other than by someone who knows a bit about programming!

Serial data files

A much better way to store data that might require up-dating or expanding, is to use a serial data file. If you only have a cassette system, this is in fact your only alternative. As with a program file, a serial data file stores the data in a continuous and contiguous stream from beginning to end, and so is subject to the same memory space limitations as a program file. The big difference is that data can be accessed, amended, deleted and added to while the program is running, then re-saved to tape (or disk) in its revised form before the program ends.

Once the program has been written and debugged, virtually anyone can use it to store, retrieve and amend the data without any knowledge of how the program was written.

Random access data files The third type of data file – random access – frees you from almost all memory limitations, but can only be used with disk systems. The number of records you can store is limited only by the amount of room on the disk – or on several disks.

If an individual record consists of, say,

NAME
TITLE
ADDRESS
TELEPHONE NUMBER
DATE OF BIRTH
DATE OF JOINING
OFFICE HELD
SPECIAL INTERESTS
DATE SUBSCRIPTION DUE

you could quite easily maintain around 600 such records on a modest, unexpanded VIC 20, provided you had a disk drive.

There are snags, of course. Random access file handling programs can seem more difficult to write and each record must be a fixed length so that the computer can work out where to find it. It also takes slightly longer for the computer to access each record because it has first to start up the disk drive, locate and load the record and then display it on the screen.

Even these minor irritations can be largely overcome or minimised by techniques such as using a serial file, loaded in at the start of the program, as an index to the random file on disk. So, in practice, random access files though largely ignored by home computer users, are often the obvious choice for serious applications.

Creating serial and random access files

Serial data files are the ones most commonly used and they are the only data files that can be handled on cassette. A serial file consists of a continuous stream of information from beginning to end, with no organisation other than that which the programmer structures when writing his data.

In just the same way that you have to open a filing cabinet drawer before you can start work on a particular file, so you have to **OPEN** a serial data file (or random access file) before you can start reading information from it, or before writing information into it. When you have finished with it you must then neatly **CLOSE** the file. If you do not, the computer does not know that you have come to the end and will not mark the file end or put the last of the data away from its working area (see below). It can not be **OPEN**ed for reading and writing simultaneously and must be opened at the beginning and read or written from beginning to end by the program. Thus, it is not possible to go backwards, so once the file is closed it is necessary to start again.

As mentioned above, when opening the file it can only be opened for reading or opened for writing, not both. When writing, it starts from the beginning and writes until closed. This means that once a file has been written it cannot be updated except as follows:

(a) **OPEN** the serial file for reading.

(b) Copy the contents to a temporary serial file using **GET** and **PRINT**, **CLOSE** it or read (**INPUT#** or **GET#**) the specified variables into a suitable area such as a large array.

(c) **CLOSE** the serial file.

(d) **OPEN** the serial file for writing – the computer now assumes it is empty.

(e) Write (**PRINT#**) back the contents from specified variables or from the temporary file created after opening it for reading. This overwrites the file that was previously held there.

(f) Add the new information to the end of the file, or combined with (e) above, insert new or modified information as required.

This may seem strange to someone unused to computing files, but if it were not so, then every time a file was opened for writing the cassette tape would have to start at the beginning and run right through to find the end. Don't worry if you can't immediately understand the procedures above at a first reading, it will become clear once you set about using serial files and work out what you want to do using the I/O (Input/Output) instructions (**OPEN#**, **CLOSE#**, **INPUT#**, **GET#**, **PRINT#**)

The data would then progressively overwrite any other files following on the tape.

Random files are only to be found on disk. The disk manual explains these, and how to use them to build indexed files. Here the file is set up with a fixed size and with records ordered in a particular fashion, gaps being left in the structure for future inserts. Each record has an address or record number so records can be easily inserted, deleted and replaced. The number of records is limited only by the size of the disk, but practically for the sort of information described earlier it would be one record per sector (each sector having 254 bytes available for information).

File Buffers

All files are addressed from the computer using buffers. For programming purposes these buffers are said to be transparent to the user, i.e. the programmer does not have to worry about handling them as this is done by the computer. However it helps to follow the way programs operate, to understand the buffer system. To take the cassette case, each time a character or a string is sent to a cassette file, it does not make sense to start the cassette motor, wait for it to reach speed, send a character, then stop, and repeat the process for each item of data it wants to save. So, by convention, characters are saved up in a buffer and then when the buffer is full (192 characters for a cassette) the entire buffer is written to the tape in one go.

When the program finishes using the file, any information left in the buffer will not have been put on to the tape because it won't have reached the total of 192 characters needed to cause an automatic writing of the contents of the buffer to tape. So we must make sure that the information in the buffer is not lost, by 'forcing' it to be written to tape. This is done by using the **CLOSE** command which writes away the rest of the data to be stored. The input and output to disk and the output to the printer are handled in the same way. Reading works in the reverse manner.

A few routines to handle disk access are shown above opposite.

```
110 oPen 15,8,15
130 Print "██":Poke 53281,1:Poke 53280,3
140 Print "███________________________________
    ____"
150 Print "██i              █main menu█"
160 Print "██▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔
    ▔▔▔"
170 Print tab(10);"♀d - directory"
180 Print tab(10);"♀s - scratch"
190 Print tab(10);"♀n - new disk"
200 Print tab(10);"♀r - rename a file"
205 Print tab(10);"♀x - exit"
206 Print tab(10);"♀e - error status"
210 Print "██enter the letter:"
220 Print "████████████████████████████  "
230 get ky$:if ky$="" then 230
240 Print "█████████████████████████████";ky$
250 if ky$="d" then 300
260 if ky$="s" then 1000
270 if ky$="n" then gosub 1200
280 if ky$="r" then gosub 1400
284 if ky$="e" then gosub 1700
285 if ky$="x" then close 1:close 15:Print "██":en
    d
290 goto 140
300 rem ****************************
310 rem ***    disk directory     ***
320 rem ****************************
325 oPen 1,8,0,"$0":rem for dir
330 f=0
340 get#1,a$,b$
350 get#1,a$,b$:get#1,a$,b$
360 gosub 530:gosub 600:gosub 680
370 d$="██"+fl$+"█"+tP$
380 Print "███________________________________
    ____";
390 Print "██i    █directory█ of ";d$
400 Print "██▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔
    ▔▔▔"
410 get#1,a$,b$
420 get#1,a$,b$
430 gosub 530:gosub 600:gosub 680
435 if fl$="" then 470
440 bl$=right$(bl$,2):gosub 740:rem Printing
450 f=f+1:if f>16 then f=0:gosub 510:goto 380
460 goto 410
470 rem *****  ending    *****
474 Print "    ██";bl$;" blocks free█"
475 gosub 510:close 1
480 goto 140
490 :
500 :
510 get ky$:if ky$="" then 510
520 return
530 rem ****   reading no.blocks taken uP by each
    file  ****
540 c=0
550 if a$<>"" then c=asc(a$):rem reading no.blocks
    taken by file
560 if b$<>"" then c=c+asc(b$)*256:rem ditto
570 block$=str$(c):rem bl$
580 return
590
600 rem ****  reading name - looks for quotes  ***
    *
610 fl$=""
620 get#1,b$:if st<>0 then fl$="":return
630 if b$<>chr$(34) then 620:rem look for quotes
640 get#1,b$:if b$<>chr$(34) then fl$=fl$+b$:goto
    640:rem ** each file name
650 get#1,b$:if b$=chr$(32) then 650
660 return
670
680 rem ****  tyPe of file  ****
690 c$="":if fl$="" then return
700 c$=c$+b$:get#1,b$:if b$<>"" then 700
710 tP$=left$(c$,3)
720 return
730 :
740 rem ****  Printing  ****
750 Print "";bl$;"█";tab(3);fl$;tab(18);"";tP$
760 return
770 :
780 :
790 :
1000 Print "███_______________________________
    _____";
1010 Print "██i              █scratch█"
1020 Print "██▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔
    ▔▔▔▔"
1030 inPut "file name";fl$
1040 Print#15,"scratch0:"fl$
1050 gosub 2000
1060 goto 140
1200 Print "███_______________________________
    _____";
1210 Print "██i              █new disk█"
1220 Print "██▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔▔
    ▔▔▔▔"
1230 inPut "disk name█";dm$
1240 inPut "id no. (oPtional)█";oP$
1250 Print#15,"new0:";dm$",";oP$
1260 gosub 2000
1270 return
1400 Print "███_______________________________
    _____";
```

```
1410 print "█i                █rename█"
1420 print "██────────────────────────────────
     ───"
1430 input "old file name█";on$
1440 input "new file name█";nn$
1450 print#15,"rename0:";nn$"="on$
1460 gosub 2000
1470 return
1480 :
1700 rem ******************************
1710 rem ***    routine for check   ***
1720 rem ******************************
1721 print "███───────────────────────────
     ─────";
1722 print "█i                █error status█"
```

```
1723 print "██────────────────────────────────
     ───"
1730 gosub 2000
1740 if en=0 then print en,em$,t,s
1750 get ky$:if ky$="" then 1750
1760 return
1770 :
2000 rem ******************************
2010 rem ***      check disk       ***
2020 rem ******************************
2030 input#15,en,em$,t,s
2040 if en=0 or en=1 then return
2050 print en,em$,t,s
2060 for n=1 to 1000:next:return
```

SECTION 2 BASIC FUNCTIONS

This section includes a detailed description of the BASIC functions of the CBM language as applied to the VIC 2Ø or CBM 64. The language was derived from the PET BASIC which means that many programs written on PETs from 1977 onwards are not difficult to convert for use on the newer machines.

Conventions used in the syntax are as follows:
< and > indicates an entry of the type described within the angle brackets.
[and] indicate an optional entry.
( ) and , are typed as shown.

The examples below the syntax statement under each BASIC word use the conventions mentioned above.

BASIC words can be abbreviated by using the table in the manual or by remembering that the abbreviation consists of sufficient letters to allow the word to be differentiated from other words, with the last letter shifted. **PRINT** is an exception, for this the abbreviation is just '?'

ABS

Description
Gives a number without its sign.

Syntax
ABS (<numeric>)
e.g. ABS(-1) gives 1.

Function Very simply, **ABS** leaves a positive number as it is and removes the sign on a negative number making it positive. Not often used, two examples are shown below.

```
X=SQR(ABS(Y))
```
will prevent a square root being attempted on a negative number.
```
X=ABS(A-B)
```
finds the difference between two numbers when it is not known which is the larger of the two.

AND

Description
Logical **AND** operator.

Syntax
<operand> **AND** <operand>
e.g. IF (A=1) AND (B=1) THEN.....
(the brackets are optional)

Function
AND is a binary function i.e. it works between two operands. It has two main functions:

1. As part of a logical test in an **IF** statement where **AND** indicates that both conditions must be satisfied e.g.

```
IF A<=3 AND A>=1 THEN 5Ø
```

will go to line 5Ø if A lies between 1 and 3 inclusive.

2. As a logical function on **binary numbers** with the following truth table which applies to each bit in a basic numeric variable:

X	Y	X AND Y
1	1	1
1	Ø	Ø
Ø	1	Ø
Ø	Ø	Ø

so that A=80 AND 48 will give 16 as follows:

	128	64	32	16	8	4	2	1
80 in binary is	0	1	0	1	0	0	0	0
48 in binary is	0	0	1	1	0	0	0	0
AND gives 16 as	0	0	0	1	0	0	0	0

where 80 represents, say, menu items 2 and 3 chosen and 48 a check for items 3 or 4

The maximum size of binary number which can be handled thus is 16 bits or two 8 bit bytes. This is the size of a basic integer (%) variable between -32768 and 32767 in decimal (being 10000000 00000000 and 01111111 11111111 in binary with decimal zero being 00000000 00000000). Note that here the leftmost bit determines if the number is negative or positive. A zero means it is positive; a 1 that it is negative. All numbers must be expressed in decimal as the VIC and CBM 64 have no facilities for handling binary numbers.

As an example of type 1 we might wish to verify entries on cassette, (read by an **INPUT#**) against the original entries on paper (read by an **INPUT**)

```
10 INPUT "CAR AND
COLOUR";A$,B$
20 INPUT#1,C$,D$
30 IF A$=C$ AND B$=D$ THEN
PRINT "ENTRY VERIFIED"
40 GO TO 10
```

Type 2 can be used for pattern matching when looking at a byte which does not represent a number but a pattern. For instance there may be 8 items on a menu screen from which one wishes to select items 2 and 5. This could be stored as a bit pattern 01001000, which is later matched against 10000000 to see if the first item on the menu was selected, against 0100000 for the second item and so on. In the first case 128 **AND** 72 gives 0 (try it!), so item 1 on the menu was not specified, and in the second case 64 **AND** 72 gives 64, so item 2 on the menu was specified. A typical menu might appear on the screen as follows:

```
                           [illegible]
SELECT OPTIONS FOR TEST
      (up to 3) Selected



 1 History              *
 2 Geography
 3 English
 4 French               *
 5 German
 6 Chemistry
 7 Physics
 8 Biology              *


SELECT? 1,4,8
1 selected
4 selected
8 selected
```

See also the other logical operators **OR** and **NOT**.

A small menu program for the CBM 64 using the **AND** function is given below. To maintain a simple presentation, checking of numbers input for range and other detailed validation is not included, but this program could form a basis for a multiple choice menu selection.

```
10 REM MENU SELECTION
20 REM SET UP SCREEN WITH MENU OPTIONS DISPLAYED
30 PRINT CHR$(14)"[illegible]"TAB(15)"[illegible]"
```

```
40 PRINT "♥⌐‾┤ ┌┐┐⌐/♥ ┘┌_ ┌‾♥┤(UP TO 3)"
50 PRINT TAB(15)"◣♥ELECTED▓▓▓▓▓"
60 FOR I=1TO8:READ IT$
70 PRINT I;IT$:NEXT I:PRINT:PRINT
80 INPUT "◣♥⌐‾┤▓";SL(1),SL(2),SL(3)
90 REM ALLOW THE 3 SELECTIONS
100 FOR J=1 TO 3:PRINT "▓▓▓▓▓":BP=1/2
110 IF SL(J)=0 THEN 140
120 FOR K=1 TO SL(J):PRINT:BP=BP*2:NEXT K:MS=MS OR
      BP
130 PRINT TAB(20)"*"
140 NEXT J
150 REM TEST FOR ITEM(S) SELECTED
160 PRINT "▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓"
170 IF MS AND 1 THEN PRINT "1 SELECTED"
180 IF MS AND 2 THEN PRINT "2 SELECTED"
190 IF MS AND 4 THEN PRINT "3 SELECTED"
200 IF MS AND 8 THEN PRINT "4 SELECTED"
210 IF MS AND 16THEN PRINT "5 SELECTED"
220 IF MS AND 32THEN PRINT "6 SELECTED"
230 IF MS AND 64THEN PRINT "7 SELECTED"
240 IF MS AND128THEN PRINT "8 SELECTED"
250 STOP
260 DATA "┤ISTORY","┤EOGRAPHY","⌐NGLISH","┘RENCH",
     "┤ERMAN","┤HEMISTRY"
270 DATA "⌐HYSICS","┤IOLOGY"
```

Identical program with printer set to lower case mode.

```
10 rem menu selection
20 rem set up screen with menu options displayed
30 print chr$(14)"▓"tab(15)"▓▓TEST MENU▓"
40 print "SELECT OPTIONS FOR TEST(up to 3)"
50 print tab(15)"▓Selected▓▓▓▓"
60 for i=1to8:read it$
70 print i;it$:next i:print:print
80 input "▓SELECT▓";sl(1),sl(2),sl(3)
90 rem allow the 3 selections
100 for j=1 to 3:print "▓▓▓▓▓":bp=1/2
110 if sl(j)=0 then 140
120 for k=1 to sl(j):print:bp=bp*2:next k:ms=ms or
      bp
130 print tab(20)"*"
140 next j
150 rem test for item(s) selected
160 print "▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓"
170 if ms and 1 then print "1 selected"
180 if ms and 2 then print "2 selected"
190 if ms and 4 then print "3 selected"
200 if ms and 8 then print "4 selected"
210 if ms and 16then print "5 selected"
220 if ms and 32then print "6 selected"
230 if ms and 64then print "7 selected"
240 if ms and128then print "8 selected"
250 stop
260 data "History","Geography","English","French",
     "German","Chemistry"
270 data "Physics","Biology"
```

ASC

Description

Gives the **ASCII** value of the first character in a string.

Syntax

ASC(<string>)

e.g. ASC ("2") is 50
ASC ("A") is 65
ASC ("B") is 66

Function

ASC is the reverse operation to **CHR$** and gives the **ASCII** equivalent number of the first character in a string. If no character is present an "ILLEGAL QUANTITY" error occurs.

A character in a string is stored in memory as a number. This number is found in the **ASCII** conversion table in your user manual, for upper case mode. Lower case mode is stored in exactly the same way and using the same numbers as for the equivalent upper case. This is because the machine does not recognise any difference in storage between upper and lower case mode, and the character displayed by a **PRINT** statement or otherwise on the screen depends entirely on the mode that the computer is operating in at the time. For convenience the complete table (excluding control codes but including lower case) is shown in Appendix A.

As examples:

PRINT ASC(X$)–48

will give the value of a single digit number stored as a string character (if X$ is 2 the answer will be 2).

```
PRINT ASC("JONES")
```

will give only the the value of "J" i.e. 74. If other values within a string are required this can be done using **MID$** e.g.

```
PRINT ASC(MID$("JONES",2,1)
```

will give the **ASCII** value of the second character of the string "JONES".

```
PRINT ASC(A$+CHR$(Ø))
```

will prevent an ILLEGAL QUANTITY error occurring if A$ contains no characters.

ATN

Description
Trigonometric arctan.

Syntax
ATN(<numeric>)
e.g. ATN(2+A)

Function
This is the complement of **TAN**, turning a tangent back into an angle (in radians) e.g.

```
A=ATN(B)*18Ø/∏
```

converts a tangent to an angle in degrees.

Your machine has a ∏ function, so ∏ is available direct and there is no need to derive it from the trigonometric functions. For interest, on computers without a ∏ function, pi can be derived from **ATN** as ∏=ATN(1)*4. This is because the angle whose tangent is 1 is 45 degrees or ∏/4 radians.

CHR$

Description
Converts a number to its **ASCII** equivalent.

Syntax
CHR$(<numeric>)
e.g. CHR$(5Ø) gives the string "2" in both modes
CHR$(65) gives the string "A" or "a"

Function
This is the reverse instruction to **ASC**, and the concept is explained there. The number must be between Ø and 255 or an ILLEGAL QUANTITY error results. A non-integer is truncated e.g. **CHR$(5Ø.89)** still gives 2. It is very useful for storing codes which cannot be printed directly as, for example, the **<RETURN>** key which is **CHR$(13)**. It is also useful for changing the printer modes (explained in the printer manual). **CHR$(34)** encodes the " sign, which is otherwise very difficult to handle as the computer enters " (quote) mode every time you type it on the screen.

See also **ASC** and the table of **CHR$** values and strings in Appendix A.

CLOSE

Description
Closes a file.

Syntax
CLOSE <file number>
e.g. CLOSE 4 closes file no.4

Function
CLOSE informs the computer that the program has finished processing a file or device (e.g. printer), either permanently or temporarily. **CLOSE** is necessary so that at the end of processing the file can be properly cleared from the system. Therefore when writing to a file, any remaining information waiting in the file buffer to be processed is sent to the disk, cassette or printer and the end of file marker is written, if requested. The input-output (I–O) channel is also freed in the case of the printer (but see also **PRINT#** and **CMD**), which ensures that disk information (sent along the same line) is not held up by the printer awaiting information.

If the file number is given as a zero, a message such as NOT INPUT FILE ERROR will appear. If the file number is not an integer it will be truncated to an integer, and if a file number is specified that had not been opened, no action is taken but no error messages are given. If a string is given (instead of a number) a TYPE MISMATCH ERROR occurs.

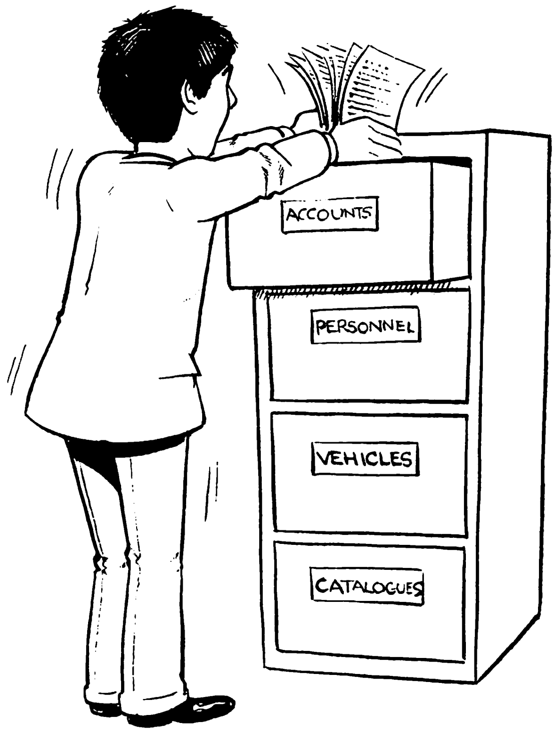
CLOSE can be used directly or within a program. It is worth noting that closing files can take some time especially when closing the cassette, as time has to be taken to write the cassette buffer. In the case of serial cassette files, remember to rewind before opening again if required in the same program.

```
100 FOR I=1 TO 10:CLOSE I:NEXT
```

closes any files with numbers between 1 and 10 that have been opened.

Note that **CLOSE** on its own does not work on CBM computers, although available on many others where it closes all open files

See also Section 1 on file handling and I–O.

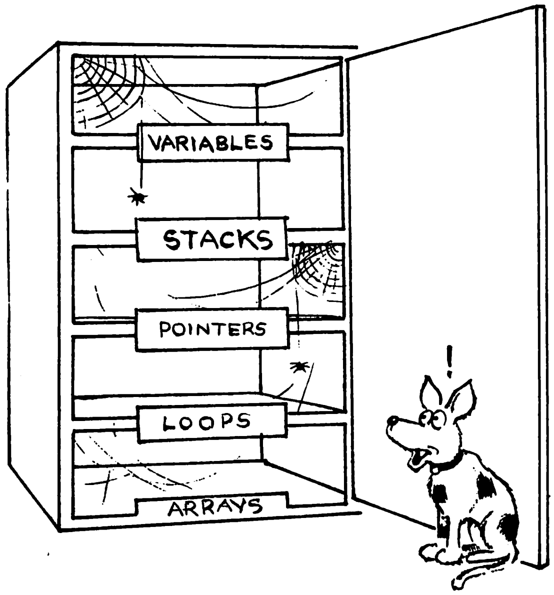


CLR

Description
Clears all BASIC variables.

Syntax
CLR

Function
CLR clears all BASIC from RAM except the screen RAM (which means the screen is not cleared) and the BASIC program itself which is there as if it had just been loaded. This is not a clever instruction, it doesn't close files for instance, so it is necessary to make sure everything is closed before using it. Assembler (machine language) and other locations such as sound and colour are not affected



CMD

Description
Alters the output from the screen to another device.

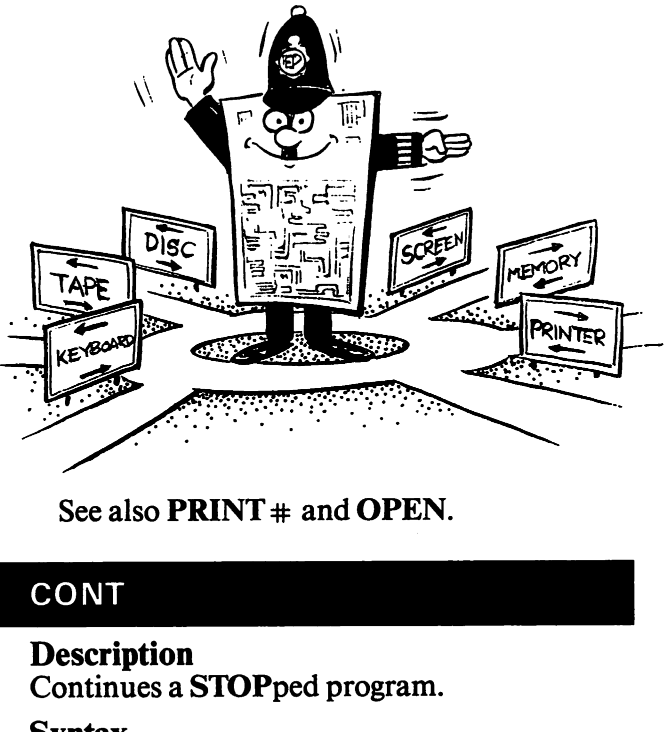
Syntax
CMD <file number> [,<string>]
e.g. CMD4 reallocates output to the printer which has been previously opened as file number 4

Function
This very useful command used mainly in direct mode, but also available for program use, requires an **OPEN** to have been executed for the file required and then sends all system or program output to that file. The file may, of course, be a device such as a printer, with a file number associated with it by the **OPEN** command. Any **PRINT** or **LIST** data will be sent to the file until the CMD statement is reversed.

A **PRINT#** sent to the output, followed by a **CLOSE** command to write the buffer away and revert to the screen, ends the sending of the data.

An error such as SYNTAX ERROR cancels the **CMD** and returns output to the screen, but a **PRINT#** should still be used in direct mode to clear any device or it may not respond when the next output is sent to it, and the system will hang up, waiting.

OPEN4,4:CMD4:LIST will list a program
PRINT#4:CLOSE4 reverts to the screen.



See also **PRINT#** and **OPEN**.

CONT

Description
Continues a **STOP**ped program.

Syntax
CONT.

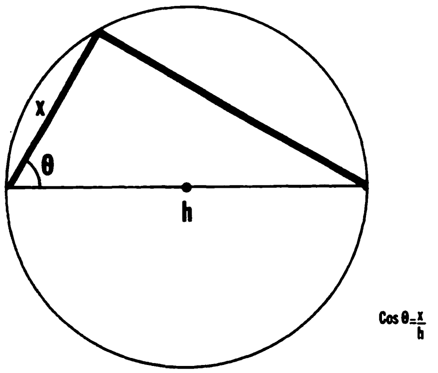
Function
This is normally used after a **STOP** to resume the program. It can also be used after the <STOP> key has been depressed or after an END. It won't work (CAN'T CONTINUE) if any program editing has taken place - and this includes pressing <RETURN> in the middle of a BASIC line even if no changes have been incorporated. It also won't work if an error has occurred either to stop the program or while, say, looking at variables after the program has stopped. See also **STOP** and **END**.

COS

Description
Trigonometric cosine function, provided in a right angled triangle by the equation **COS** A= adjacent side/hypotenuse.

Syntax
COS (<NUMERIC>) e.g. COS (Ø) gives 1

Function
The cosine of an angle (in radians) is produced. See also **TAN**, **SIN** and the table of other trigonometric functions in your user manual.



DATA

Description
Provides data embedded in the program.

Syntax
DATA <constant>[,<constant>]....
e.g. DATA 1Ø,JAMES,12,MARGE,"AT HOME:456,AT WORK:2292"

Function
For the way **DATA** is used see **READ**. The constants in **DATA** statements must be enclosed in quotes if they contain commas, colons or cursor control characters.

DEF FN

Description
Defines a mathematical function.

Syntax
DEF FN <name>(<numeric variable>)= <numeric>
e.g. DEF FNA(N)=N+1/N

Function
If you have a complicated formula used in several places, it is best defined at the start of the program with the **DEF FN** statement to save space later. This is frequently used with **RND.** A **DEF FN** should appear near the start of the program amongst other non executable statements such as **DIM**.
Some examples:

```
DEF FNA(N)=INT(RND(1)*N+1)
```

gives a random integer number between 1 and N whenever the function is called, perhaps by A=FNA(5) giving 1,2,3,4 or 5. The **DEF** statement is in an early line, perhaps 5Ø or so, directly after the **REM** statements describing the program, and the calls (e.g. A=FNA(5) or A=FNA(7) or A=FNA(X)) occur whenever it is required to perform the function defined. So A=FNA(7) would be equivalent to A=INT(RND(1)*7+1). The letters after the **FN** enable you to have as many such formulae defined at the start of your program as you wish. For example:

```
DEF FNB(R)=Π*R2
```

gives the area of a circle whenever called by say AR=FNB(1Ø) the area of a circle of radius 1Ø.

```
DEF FNRD(X)=INT(((1Ø^N)*X)+Ø.5)/
(1Ø^N)
```

rounds off to N decimal places and

```
DEF FNM12(X)=12*(X/12–INT(X/12))
```

converts a 24 hour clock into a 12 hour clock.
Remember to check that the function you want is not already explicitly defined in BASIC e.g.

```
SIN(X)/COS(X)
```

is equivalent to TAN(X) so there is no need for

```
DEF FNA(X)=SIN(X)/COS(X).
```

DIM

Description
Dimensions an array

Syntax
DIM <array name>(<number>[, <number>]......)
e.g. DIM A$(25) is an array of 26 elements (Ø-25 incl)
DIM B(11,11) is an array of 144 elements in two dimensions

Function
An array is a collection of variables ordered one after the other in list form or matrix form if greater then one dimension. This makes it easier to process a list within a FOR loop or wherever indexing is used:

```
100 FOR I=1 TO 10
110 INPUT "NAME";NA$(I)
120 NEXT I
```

or

```
100 FOR I=1 TO 10
110 INPUT "NAME";NA$(I)
120 FOR J=1 TO 4
130 INPUT "ADDRESS";AD$(I,J)
140 NEXT J,I
```

will fill a list of names or names and addresses. Every array must be dimensioned either by using a **DIM** statement or by letting the computer do it for you. If there is no **DIM** statement, your array will be dimensioned with 11 elements from Ø to1Ø or 121 (11 * 11) elements if a two dimensional array, 11*11*11 for a three dimensional array and so on the first time the program encounters it while running. If you dimension an array twice (i.e. if the program runs through a **DIM** twice or does its own implicit **DIM** before finding yours) an error REDIM'D ARRAY will occur. Any **DIM** statements should therefore be put at the beginning of the program directly after any introductory **REM** statements. Note that as multi dimensional arrays use a lot of space, two

dimensional arrays should be used with care, three dimensional arrays only on very special applications and four dimensional arrays will prove almost impossible to use anyway.
See also **FOR**.

END

Description
Stops a BASIC program.

Syntax
END

Function
END has the same function as **STOP** except that the message BREAK IN LINE ... does not occur. See **STOP** for further details.
END is a neat way of ending programs and it is better than just allowing the program to run off the end of the code. It ensures that the program ends where you want it to, so that if you put a subroutine or error handling routine for instance, beyond the end of the main program code it won't get run unintentionally:

```
      :
      :
170 FOR N=1 TO 10:
PRINT#4,N:NEXT
180 GOSUB 300
190 CLOSE1:CLOSE4
200 END

300 REM SUBROUTINE........
```

More than one **END** can appear in a program.

EXP

Description
Calculates powers of the constant e.

Syntax
EXP (<numeric>)
e.g. EXP(Π) is 23.1406926

Function
The mathematical exponential constant e is raised to the power given by <numeric>. It is related to the **LOG** function which uses a base of e, for example EXP(LOG(10)) IS 10.
Useful in many mathematical equations, the mathematician alone understands!

FN

See **DEF FN**.

FOR

Description
Control statement for the generation of a loop.

Syntax
FOR <variable>=<numeric1>**TO**
<numeric2>[**STEP**<numeric3>]
:
:
NEXT [<variable>]
e.g. FOR X=1TO10:............:NEXT

Function
FOR allows the program to loop round a section of code enclosed by the **FOR** and **NEXT** statements a controlled number of times, usually (numeric2–numeric1)/numeric3. If the optional **STEP** is not entered, a step of 1 is assumed.
After each **NEXT**, the variable is incremented and a test is made to see if it is greater than the control end <numeric2>. If it is, the program continues with the statement after

NEXT, otherwise the loop is entered again. Note that this means that the **FOR** loop will always execute at least once. This differs from many other BASICs where the **FOR** loop is not performed at all unless the conditions for it are satisfied at the entry point.

There is nothing to prevent manipulation of numerics 1,2 and 3 within the loop if they are variables, but obviously care must be taken doing this as it makes the logic of the program more difficult to follow, and it sometimes becomes quite difficult to calculate how many times the loop will actually execute for any given set of conditions. There is also nothing to prevent you jumping out of the **FOR** loop if some other condition such as end of line or end of file is encountered.

Note that **STEP** can be negative as well as positive, allowing you to step down an array from the top as well as up from the bottom. It is essential to specify **STEP** when negative.

At the end of the **FOR** loop, if it completes normally, the <variable> has the value it had for its last test at **NEXT**, which will be more/less than the maximum/minimum specified by **TO** and will be the value the next **STEP** has incremented or decremented it to when finding that it was outside the bounds of the loop.

```
10 FOR X=1 TO 10
20 PRINT X
30 NEXT
40 :
   :
X is always 11 on exit.
```

Jumping out of a loop

```
100 LN=1
110 FOR X=1 TO 10
120 PRINT Y$(X);
130 IF POS(0)>LN THEN 300
140 NEXT X
150 PRINT:PRINT "OK
IN"LN"CHARS":END
       :          :
       :          :
300 REM LINE FULL ROUTINE
310 PRINT:REM SKIP A LINE
320 PRINT "TOO MANY WORDS TO
FIT IN"LN"CHARS":PRINT:LN=LN+1
330 GOTO 110            :
```

The value of X on exit depends on the lengths of the strings in the array Y$(X) when the code is run and the program continues to look for another **NEXT** after line 300 so design and debugging becomes that bit more difficult. Furthermore a loop variable used internally by BASIC is left on the BASIC stack and will not be removed until a **CLR** or **RUN**. A better way might be as follows:

```
100 LN=1
110 FOR X=1 TO 10
120 PRINT Y$(X);
130 IF POS(0)>LN THEN GOSUB
      300:X=11
140 NEXT X
150 IF X=12 THEN 110
       :          :
       :          :
300 REM LINE FULL SUBROUTINE
310 PRINT:REM SKIP A LINE
320 PRINT "TOO MANY WORDS TO
FIT IN"LN"CHARS":PRINT:LN=LN+1
330 RETURN
```

X is 11 on exit if the string fitted or 12 if it did not.

In all cases the variable following **NEXT** is optional and is used for clarity only. If not used the speed of the loop is much increased.

If an attempt is made to change the **STEP** after the loop is running, nothing happens, as once the **STEP** has been set up it cannot be changed even if the variable used to set it is changed. Thus the code below will not work to increase the size of the step from within the loop:

```
100 Y=1
110 FOR X=1 TO 1000 STEP Y
120 PRINT X;
130 IF X>9 THEN Y=10
140 IF X>99 THEN Y=100
150 NEXT
       :
       :
X is 1001 on exit.
```

Lines 130 and 140 alter Y but have no effect on the step.

A **FOR** loop can also be used for a simple delay, perhaps to give people a chance to read a screen. Delays can be better handled in other ways in machine language, but for BASIC programmers this is an acceptable method unless the code is to be compiled, in which case the delay will be much reduced due to the greater efficiency of the compiled code. Another method is to use the internal clock, which will work unless the cassette is in operation actually reading or writing.

FOR loop delay:
FOR X=1 TO 1000:NEXT

Time delay:

```
100 TI$-"000000":REM
 SET INTERNAL CLOCK
110 IF TI<(5*60)THEN
     110:REM WAIT FOR CLOCK
120       :
```

(see under **TIME** for explanation of TI$ and TI)

This gives a precisely timed 5 second delay, whereas the only way to determine the time in a **FOR** loop is by experiment. However the **FOR** loop is a little more compact in code. Compiled code is much more efficient and therefore much faster and will thus shorten considerably such timing loops.

A **FOR** loop should normally be used for stepping up or down an array:

```
FOR I=1 TO16:AR(I)=0:NEXT:REM
CLEARS AN ARRAY
```

or:

```
10 DIM AR(16)
  :     :
100 FOR I=16 TO 1 STEP-1:IF
AR(I)<>0 THEN PRINT I
110 NEXT
```

Nested loops are very powerful and you will soon find occasion to use them. A two dimensional array, perhaps a draughts board can be set up this way:

```
100 REM CLEAR ENTRIES ON
DRAUGHTS OR CHESS BOARD
110 FOR I=1 TO 8
120 FOR J=1 TO 8
130 DB$(I,J)=""
140 NEXT J,I
```

The maximum number of **FOR** statements that can be nested is 1Ø, which is more than adequate. Only a program error should give the condition OUT OF MEMORY. If using multiple nested **FOR**s be careful not to use the same variable in any two loops. If you do the result will be a NEXT WITHOUT FOR error.

An example of **FOR** loops nested 3 deep is given below:

```
10 REM THREECOM
20 REM PRODUCES ALL SUMS OF ANY 3 OF THE NUMBERS E
    NTERED
30 REM STOPS WHEN OPTIONAL MATCH FOUND
40 OPEN 4,4
60 INPUT "NUMBER TO MATCH";NM
70 N=1
80 INPUT"NEXT NUMBER";A(N):IF A(N)=0 THEN X=N-1:GO
    TO 100
90 N=N+1:GOTO 80
100 CMD4
105 FOR N=1 TO X-2
110 FOR A=N+1 TO X-1
120 FOR B=A+1 TO X
130 Z= A(N)+A(A)+A(B)
140 PRINT Z"  ";:IF Z=NM THEN PRINT "▨"A(N);A(A);A
    (B)"■":END
150 NEXT:PRINT:NEXT:PRINT:NEXT
160 PRINT#4:CLOSE4:END

READY.
```

Some of the examples in Section 3 also use nested **FOR** loops See also **NEXT**.

FRE

Description
Performs garbage collection and gives free space available.

Syntax
FRE(<dummy>)
e.g. FRE(8)

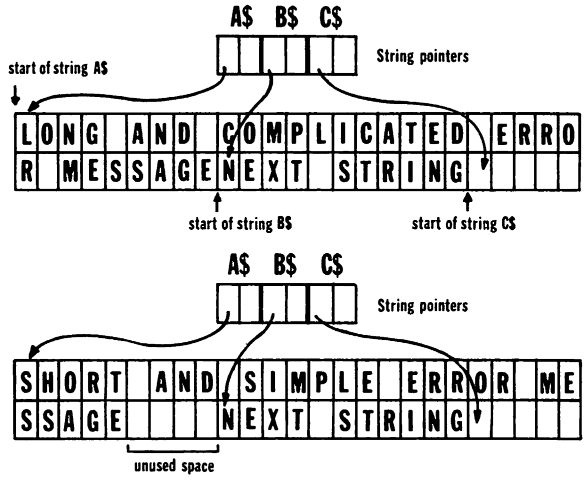
Function
In BASIC, strings and other variables are created dynamically and also deleted and extended dynamically, which makes it impossible to arrange all the data neatly in memory. Some gaps and thus wasted memory are bound to occur. For instance if a string A$ is first created by A$="LONG AND COMPLICATED ERROR MESSAGE" and B$ is then created as another string, A$ and B$ are created one after the other in memory (string space, to be precise). This means that if A$ becomes the shorter "SHORT AND SIMPLE ERROR MESSAGE" then a few spare bytes appear, which cannot be used unless another string is the same length or less than the hole created. In this manner, as a program goes on manipulating strings, the free memory gets scattered about within the computer and this will stop BASIC from time to time when it runs out of space and has to do a garbage collection.

Garbage collection is the computer jargon for repacking all these strings, recovering all the free space and packing it into one area. **FRE** carries out this garbage collection and gives the amount of memory free. If the amount of memory spare when your program is running is small, it is often advantageous to do a **FRE** from time to time to prevent the program having to do it at a time not of your choosing. For example you might use **FRE** to do a garbage collection while a menu or instructions are being displayed on the screen then the delay caused by the garbage collection will not normally be noticed.

There is a bug in **FRE** which shows up on the CBM 64 in that **FRE** gives a negative number if more than 32k of BASIC memory is available. The correct answer is given by adding 64k (65536) to the **FRE** number or by:

```
FRE(8)-(FRE(8)<Ø)*65536
```

which you will need in a program if checking to ensure that the user has sufficient space to continue.



GET

Description
Examines the keyboard for character entry.

Syntax
GET <variable> [,<variable> .....]
e.g. GET A$

Function
GET picks up any keyboard entry. If nothing has been entered since the last **GET**, an empty string (or Ø if the variable is a numeric type) is returned. **GET** does not wait and the program proceeds immediately with the next statement, so the usual way to use it is to return to the **GET** until something is found e.g.

```
1Ø GET A$:IF A$="" THEN 1Ø
```

GET is more flexible than **INPUT** and has many advantages, but is usually a bit more complicated to program.

Commas, **RETURN**s and any other characters can be used.

String length can be up to 196 characters.

Undesired characters (perhaps cursor controls) can be ignored by the program, or certain keys or combinations of keys only accepted e.g.

```
1Ø GET A$:IF VAL(A$)=Ø THEN 1Ø
```

or:

```
1Ø GET A$:IF A$=""THEN 1Ø
2Ø IF VAL(A$)<>Ø THEN 5Ø:REM
ACCEPT A NUMBER
3Ø IF ASC(A$)>63 AND ASC(A$)<
   71 THEN 5Ø:REM HEX A TO F
4Ø GOTO 1Ø
5Ø REM PROGRAM CONTINUES
WITH A HEX CHARACTER IN A$
```

Unlike **INPUT**, **GET** does not echo the input characters on the screen, which gives you the flexibility of echoing just the ones you want, using **PRINT** or **POKE** statements.

The expanded syntax **GET** A$,B$,.. is not often used because in normal use **GET** will only pick up one character. However if there is a delay before the **GET**, this gives time for keys to be pressed and stored internally in the keyboard buffer, which has the characteristics of a queue, until the **GET** is encountered which reads them:

```
11Ø FOR X=1 TO 1ØØØØ:NEXT
12Ø GET A$,B$,C$,D$...
```

A maximum of 1Ø characters can be held in the keyboard queue: any more than 1Ø are lost unless **GET** has taken some from the front of the queue. Unlike **INPUT**, if **GET** finds a mismatch when a numeric is given a non-numeric key, SYNTAX ERROR appears and the program stops. It is therefore always best to use a string variable (e.g. A$ and then convert to a numeric by using VAL(A$) with a program check for non-numerics if required). For example, if "A" is entered in error instead of a number when the program is at a line containing **GET** X or **GET** X%, there will be a SYNTAX ERROR. In addition, the normal check shown above (1Ø GET A$:IF A$=""THEN 1Ø) cannot work and must be replaced by something like:

```
1Ø GET A:IF A=Ø THEN 1Ø
```

which means that Ø cannot be entered as a valid reply.

GET#

Description
Reads characters singly from a file or device.

Syntax
GET# <file number>,<variable>[,<variable>.......
  e.g. GET#1,A,B$,C

Function
GET# works the same way as **GET** except that the data comes from a file or device instead of the keyboard. No characters are specially treated, but are simply read one at a time and placed in successive variable names. This means that any data separation characters inserted in the file when writing (perhaps commas and **RETURN**s) must be analysed separately by the BASIC program. Before **GET#** can be used the file being accessed must have been **OPEN**ed. As an example:

```
1Ø OPEN 8,8,8,"Ø:FILE1"
2Ø GET#8,A$
3Ø IF A$=CHR$(13) THEN 5Ø:REM
LOOK FOR RETURN
4Ø LN$=LN$+A$:GOTO 2Ø
5Ø PRINT LN$:LN$="":GOTO 2Ø
      :
      :
  CLOSE 8
```

When using **GET#** on cassette, the characters are read out of the cassette buffer which is refilled as required (see File Handling in Section 1) from time to time. The program pauses and the clock stops while tape input or output is in progress.

GOSUB

Description
Calls a subroutine.

Syntax
GOSUB <line number>
  e.g.GOSUB 5ØØ

Function
GOSUB causes control to be transferred to the line number specified and stores the return address as the statement following the **GOSUB**. Control is passed back when a **RETURN** is encountered in the subroutine e.g.

```
1Ø REM SET UP SCREEN
2Ø GOSUB 1ØØØ
3Ø PRINT N
```

```
      :
      :
100 END
1000 REM CLEAR SCREEN AND SET
PAGE
1010 PRINT <clr>
    ">>>>>>>>>>>>>>>>";
1020 PRINT "PAGE";
1030 RETURN
```

Lines executed will be: 10 20 1000 1010 1020 1030 30.....etc Notice the **END** at line 100. This is a useful safety precaution at the end of any program before subroutines start so as to prevent the program dropping through from the main program into the subroutine accidentally and causing a RETURN WITHOUT GOSUB error. Subroutines can equally well be placed at the front of the program before main code with a jump from say line 10 to the main code.

GOSUBs can be nested i.e. a routine can call another routine, which itself can call another. It is easy to nest subroutines accidentally by forgetting to put **RETURN** in. This can lead to most peculiar results as the code being executed is totally unexpected, and the return from any other **GOSUB** so entered will be to the wrong place. This is because the return line number is picked off the stack as the last one put there.

GOSUBs can be nested up to an unbelievable 24 deep, so always check your **RETURN**s particularly carefully in complicated code.

The purpose of **GOSUB** is to allow frequently repeated code to be put in one place and called from any part of the program. It can also be used to make the code more understandable, by taking out detail from the main code into subroutines thus allowing both the main code logic and the subroutine logic to be followed more easily. Note that a **GOSUB** can point to any valid line including a **REM** line, but cannot point to an undefined line. Calculated line numbers cannot be used:

```
100 A=10:GOSUB A
```

is invalid.

See also **ON**.

GOTO

Description
Jumps to another part of the program.

Syntax
GO TO <line number> or equivalently GOTO <line number>. e.g. GOTO 70

Function
GOTO is an unconditional jump to another part of the program without returning. This should be avoided wherever possible except for short loops (as in **GET** handling), for **ON** (q.v.) or for simple skip overs (see **IF**) or errors. This is because unrestricted use of **GOTO**s make the logic of a program more difficult to follow, particularly if used indiscriminately or with flags (see design hints in Section 1). The intertwining logical paths created by large numbers of **GOTO** statements result in what is commonly known as 'spaghetti software'. If you find that your program seems to need this kind of structure (or more accurately non-structure) it is wise to have another look at the logic of your design and see if it can be rearranged. Unfortunately BASIC was not designed as a structured language, and you will find in Section 3 fairly frequent use of **GOTO** in some examples. Note that these are not used to jump at will about the code.

Highly structured programs are undoubtedly slower than well written unstructured code. However, in practice it is so much easier to write structured code and thus it is usually more efficient than all but the best of unstructured code. If you find performance is a problem consider using short sections of machine code within loops where the BASIC program spends much of its time, or alternatively use a compiler. No attempt is made to explain either in this book but the Commodore Programmers' Reference Guide for your machine is a good starting point for machine code, and compiler manuals are available with the compiler software. Use **GOTO** in an error situation to display an error and terminate processing; use **GOSUB** if just displaying an error message with some of error processing and continuing:

```
100 GET#1,A$:REM GET A
CHARACTER FROM TAPE
110 IF VAL(A$)=0 GOTO 1000:REM
SHOULD ONLY CONTAIN
NUMERICS
```

or equivalently

```
110 IF VAL(A$)=0 THEN 1000:REM....
```

(omitting the **GOTO** after the **THEN** if you wish)

```
        :
        :
1000 REM ERROR EXIT
1010 PRINT "NON NUMERIC
ENTRY"
1020 PRINT "PROGRAM ERROR-
ENDS"
1030 END
```

or, using **GOSUB** and returning

```
100 GET#1,A$:REM GET A
CHARACTER FROM TAPE
110 IF VAL(A$)=0 GOSUB 1000:REM
SHOULD ONLY CONTAIN
NUMERICS
        :
        :
1000 REM ERROR ROUTINE
1010 PRINT "WARNING-NON-
NUMERIC ON TAPE"
1020 PRINT "PROGRAM
CONTINUES"
1030 RETURN
```

See also **ON**.

IF

Description
Conditional statement allowing branching.

Syntax

1. **IF** <condition> **THEN** <line number> or equivalently **IF** <condition> **GOTO** <line number>
   e.g. IF X=0 THEN 1000
2. **IF** <condition> **THEN** <statement>......
   e.g. IF X=0 THEN PRINT "FUEL EXHAUSTED":Y=15:....

Note that <condition> can be a complex condition containing logical operators **AND**, **OR** or **NOT** (see below)

Function
IF is followed by a condition which can be numeric or string and can include strings, numbers and variables related by logical

operators and comparisons, but must avoid data mismatches e.g.

```
    50 IF A=0 AND B$="ABC"THEN
    GOSUB 1000
```

No **ELSE** is available in this BASIC so to achieve the same effect a **GOTO** has to be used e.g.

```
    50 IF A=0 AND B$="YES"THEN
    C$=TI$ ELSE C$="0"
```

must be written

```
    50 IF A=0 AND B$="YES"THEN
    C$=TI$:GOTO 70
    60 C$="0"
    70  :
```

Statements following a **THEN** in the same BASIC line are not executed if the **IF** condition is not satisfied, so in line 50 above if A is 1 the program moves directly to line 60. If only a small number of statements is required after a **THEN**, this is satisfactory, otherwise a **GOSUB** is required e.g.

```
    100 IF A=0 AND B$="YES"THEN
    PRINT "THIS CONDITION IS OK":
    C$=TI$:PRINT"AT TIME"LEFT$
    (TI$,2)"MINUTES"....
```

cannot be coded as it stands because there is no provision in BASIC for lines longer than about 80 characters, and while some juggling can take place removing spaces and using abbreviations, this can be more trouble than it is worth in loss of clarity and problems with later editing. It should therefore be written:

```
    100 IF A=0 AND B$="YES"THEN
    GOSUB 1000
      :        :
      :        :
    1000 PRINT "THIS CONDITION IS
    OK":C$=TI$
    1010 PRINT "AT TIME"LEFT$
    (TI$,2) "MINUTES"
      :        :
    1040 RETURN
```

INPUT

Description
A simple method of acquiring information from the keyboard, already formatted as a string or number.

Syntax
INPUT ["<prompt>";] <variable>[, <variable>].....
e.g. INPUT "ENTER YOUR NAME, AGE";NA$,AG

Function
When a program reaches the **INPUT** statement the prompt, if any, is produced and a "?" is printed on the screen, the latter being produced even if there is no prompt. The program stops and awaits input which is stored away in the variable list and may be

(a) a string
(b) a number
(c) a series of strings and/or numbers separated by commas

depending on the variables requested by the program. In any case, if nothing at all is entered (except <RETURN>) the contents of the program variables are unchanged. For example, if NA$ contains JOHN and AG contains 35, then a single press of the <RETURN> key will leave them unchanged.

If a response is entered, all the variables must be given values e.g. JOHN,36.

Note that the use of the prompt is just a shorthand way of writing **PRINT** "PROMPT";:INPUT.....

If too many replies are entered the program resumes giving a warning message "EXTRA IGNORED", and leaving out the extra items. The same effect occurs if a comma is inadvertently included, of course, as this is recognised as a string separator.

If too few are entered, the program will not continue but will produce a double prompt "??" to indicate that more entries are required.

A couple of examples illustrate the use of **INPUT:**

```
10 INPUT "AM I A CLEVER VIC";IN$
20 PRINT "I'M INTERESTED THAT
YOU SAY"IN$
30 PRINT "DO YOU FIND THIS
CONVERSATION INTERESTING"
40 INPUT IN$
50 PRINT "I THINK "IN$"TOO"
   :
   :

5 FOR N=1 TO 5: A(N)=0:NEXT
10 INPUT "HOW MANY CHILDREN
";NO
20 ON NO GOSUB 90,80,70,60,50
30 PRINT "THE AVERAGE AGE
IS"(A(1)+A(2)+A(3)+A(4)+A(5))/NO
40 GO TO 5
50 INPUT A(5)
60 INPUT A(4)
70 INPUT A(3)
80 INPUT A(2)
90 INPUT A(1)
100 RETURN
```

As can be seen above **INPUT** is easy to program within its limitations.

Some errors are checked for you and give the message REDO FROM START. These errors are mismatch errors such as entering non numeric data in an integer or numeric field. e.g. "ABC" in A or A%. However, no error message is given for a decimal number being entered into an integer field, but it will be truncated. So if 5.1 is entered into A% it becomes 5.

The insert/delete key and the cursor left/right control can be used to modify the input string without explicit programming, in just the same way that you would edit a line in the listing. The up/down cursor controls can also be used amongst others, but the use of these leads to unpredictable results.

No commas or **RETURN**s can be used in strings because these are separators and terminators. **GET** must be used in such cases. The string length is also limited to 80 characters. There is a known bug in Commodore BASIC where information displayed on the screen before an **INPUT** statement can become incorporated in the message picked up by **INPUT** e.g.

```
10 INPUT "DO YOU THINK I'M
CLEVER";IN$
20 PRINT "I'M INTERESTED THAT
YOU SAY"IN$
```

IN$ will pick up "DO YOU THINK I'M CLEVER"on the VIC as well as any message typed in. The problem is not so apparent on the CBM 64 as the screen line length is 40.

The problem occurs when a previously **PRINT**ed or **INPUT** string covers more than one line on the screen, with the **INPUT** prompt occurring on the same logical line i.e. for any **INPUT** statement with a MESSAGE greater than 22 characters (40 for the CBM 64), or for any PRINT statement longer than this length and terminated with a semi-colon. All similar constructions have the same problem so there is no simple "fiddle" to get round the problem, which should be avoided by using **GET** if necessary.

A program cannot be interrupted using the <STOP> key when a reply to **INPUT** is awaited. It is then neccessary to press <STOP> and <RESTORE> and start the program again.

Other considerations
The prompt and input can be made invisible on the screen by printing the background colour control character at the end of the MESSAGE. e.g. on a white screen:

```
10 INPUT "PASSWORD{white}";A$
20 PRINT "{blue}OK"
```

where {white} is obtained by pressing <CTRL> and 2 together and {blue} using <CTRL> and 7.

so that the letters are the same colour as the background and thus invisible. Of course the VIC, screen, cursors etc all continue to function normally – you just can't see anything. When (or before) the next **PRINT** or **INPUT** is executed the letters must be made visible again by a suitable control character.

GET is much more flexible than **INPUT** and can perform all the **INPUT** functions. **GET** should be the normal choice of the advanced programmer, but as it requires more complicated programming techniques, **INPUT** will normally be used by those with less BASIC experience.

INPUT#

Description
A simple method of acquiring information from an open file, the screen or other external device, in string or numeric form.

Syntax
INPUT# <file number>,<variable>, [<variable>.....
e.g. INPUT#1,NA$(I),AG(I)
as part of a program loading a list of names and ages in arrays NA$ and AG.

Function
This works in the same way as **INPUT** (q.v.) and has similar restrictions. The variables are separated by a <RETURN>, comma or colon and the required number of variables will be picked up from the file or device rather than from the screen (unless the screen has been designated as an input device with a **CMD**). Anything left over in the input after the last separator will be lost, and input will be ignored until the next <RETURN>, so it is important to ensure that input data is properly structured with exactly the right number of separators before the carriage return and exactly the right types of input used to match the syntax of the **INPUT** statement e.g.

```
10 INPUT#1,A,NA$,B
```

must be matched on the cassette by a series of number/ comma/ string/ comma/ number/

<RETURN>. Note particularly that no error message is given when data is lost and the program continues to read from the tape as if nothing were wrong, so particular care is required here. Separators can be commas, semi-colons or colons.

If you run off the end of the file while **INPUT**ting or try to read a string longer than 8Ø characters a "STRING TOO LONG" error appears and the program stops with a BREAK ERROR. It is therefore best to place your own end of data marker, say ZZZ on the file and look for it in the program that reads the data.

Quite complicated data patterns can be read e.g.

```
1Ø INPUT#1,NO$,Q$,A$:IF
NO$="ZZZ"THEN GOTO 4ØØ:REM
READ COMPLETE
2Ø IF Q$="ZZZ"OR A$="ZZZ"THEN
3ØØ:REM ERROR
3Ø FOR I=1 TO VAL(NO$):
INPUT#1,W$(I)
4Ø IF W$(I)="ZZZ"THEN 3ØØ:REM
ERROR
5Ø NEXT I
6Ø GOTO 1Ø
```

reads a question, answer and a variable number of wrong alternatives to construct a multiple choice type question. The routine expects a terminating ZZZ in NO$. If it finds it anywhere else it is an error.

GET# is more flexible than **INPUT#** and will perform the same functions. If the format of the incoming data is well defined in strings it is best to use **INPUT#** but if in doubt about unwanted characters such as commas, colons, semi-colons or <RETURN>s (other than as separators) then use **GET#**.

INT

Description
A simple truncation function which returns an integer value of a number or expression.

Syntax
INT (<numeric>)
  e.g. A=INT(B)

Function
INT reduces the expression to the next lower whole number, i.e. for a positive expression the decimal point and figures to the right are removed; for a negative expression the next lowest whole number is returned. If a number is already an integer it is unchanged. A simple check that an integer number has been used as a reply to an input statement might be

```
1Ø INPUT "NO OF CHILDREN",NO
2Ø IF NO=INT(NO) THEN 4Ø
3Ø PRINT "HOW DID YOU MANAGE
THE"NO-INT(NO): GOTO 1Ø
      :
      :
```

INT is a simple and straightforward function and can be used for rounding decimal numbers more simply than say **LEFT$** e.g. to round a money amount of £12.345 in A to £12.35 in B:

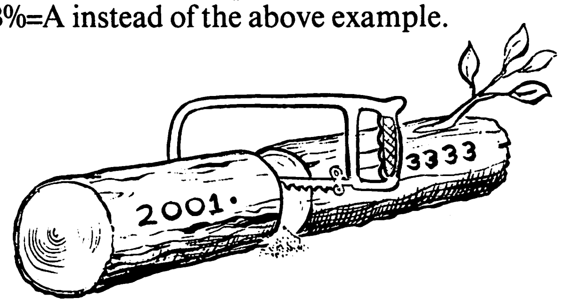
```
1Ø B=INT(A*1ØØ+Ø.5)/1ØØ
```

Note that as the next lower whole number is selected by **INT**, to get rounding Ø.5 must be added to the number to be rounded, thus bringing it over the next number if it is closer to that number than the one below.

Truncation is carried out by multiplying the number by 1ØØ, taking its integer and then dividing that by 100 with the effect that the decimal place is shifted two places into the number:

```
10 B=INT(A*100)/100 (try with A as
12.345)
```

If B is replaced by B% in the above examples the **INT** function is unnecessary so this should be borne in mind as a simpler alternative if the variable is never required to be fractional, e.g. B%=A instead of the above example.



LEFT$

Description
A string manipulation function extracting or replacing part of a string starting from the left.

Syntax
LEFT$ (<string>,<integer>)
e.g. LEFT$("JOHN SMITH",4) gives JOHN

Function
LEFT$ takes the leftmost <integer> characters of the string. The integer must evaluate to between 0 and 255. Useful in truncation or as part of a string analysis routine.

```
A$=LEFT$(B$,1)
```

takes the leftmost character of a string – useful for checking a Yes/No type answer by looking at the first character.

Quite complex syntax can be used here with good effect e.g.

```
A$=LEFT$(B$,LEN(B$-1))
```

removes the last letter of a string.

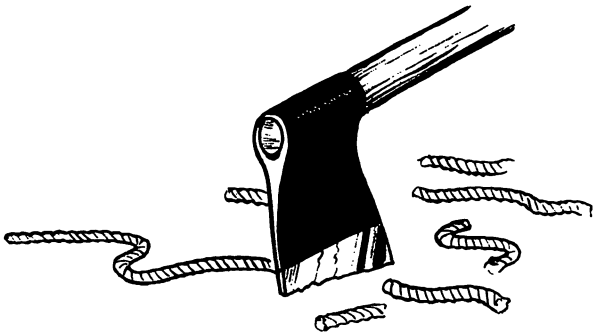
```
10 IF LEN(B$)<20 THEN 50
20 PRINT LEFT$(B$,20)
30 B$=RIGHT$(B$,LEN(B$)-20)
40 GOTO 10
50 PRINT B$
```

prints the data in B$ in widths of 20.

Another example shows how to prevent words spilling over from one screen line to another on the VIC. (For the CBM 64 use 40 instead of 22.) Line 20 takes the leftmost 22 characters of the text in C$. Line 30 removes part words from the line by shortening to the first space. Line 50 replaces the original text string with the new version which has had removed the part already **PRINT**ed. This process is repeated by returning to line 10.

```
10 IF LEN(C$)<22 THEN PRINT
C$:GOTO 70
20 D$=LEFT$(C$,21)
30 IF RIGHT$(D$,1)<>"  "THEN
D$=LEFT$(D$,LEN(D$)-1):GOTO 30
40 PRINT D$
50 C$=RIGHT$(C$,(LEN(C$)-
(LEN(D$)+1)))
60 GOTO 10
70 END
```

LEFT$**, **RIGHT$, **MID$**, and **LEN** make up the range of BASIC string handling functions and, as hinted above, can be programmed to a quite sophisticated level without necessarily writing a lot of code. However, as can also be seen above, it can be quite difficult to follow the logic, so **REM**s or separate program notes are in order. Also note that after considerable string manipulation the memory can become quite cluttered with discarded bits of string and the occasional **FRE** can be useful (q.v.).



LEN

Description
Gives the length of a string.

Syntax
LEN (<string>)
e.g. A$="19 CHARACTER STRING"
LEN(A$) gives 19

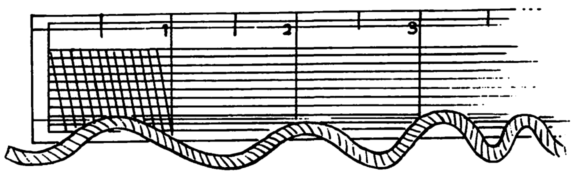
Function
LEN counts all characters including spaces and non printing characters. See **LEFT$** and **RIGHT$** for some useful examples of string manipulation using **LEN**. Other uses are e.g.

```
IF LEN(A$)=1 AND A$="X"THEN......
```

tests for the single character X.

```
110 FOR I=1 TO LEN(A$)
120 IF MID$(A$,I,1)="E"THEN
CN=CN+1
130 NEXT
```

counts the number of Es in string A$



LET

Description
Assignment.

Syntax
[LET] <variable>=<expression>
e.g. LET A=5 or LET A$=B$+C$

Function
LET assigns a value or a string to a variable and is a very common statement. The word **LET** is optional and is therefore almost invariably left out to save typing and memory. This

is unfortunate, particularly for beginners as for instance A=A+5 is nonsense to the ordinary person, whereas the meaning of **LET** A=A+5 is much more obvious.

LIST

Description
Lists all or part of a program.

Syntax
LIST [[<first line>]–[<last line>]]

e.g. LIST	lists the entire program
LIST 100	lists line 100
LIST 100–200	lists lines 100 to 200 inclusive
LIST–100	lists lines up to 100

Function
This **LISTS** required lines on the requested device (usually screen but can be printer). If used within a program, **LIST** must be the last instruction, as after a **LIST**, control is returned to the BASIC system and READY is displayed.

LISTing about 10 lines at a time on the VIC and 20 on the CBM 64 is enough to fill the screen for a normal program.

Listing to a printer can be carried out as follows:

```
OPEN 4,4:REM OPENS CHANNEL
TO PRINTER WITH ADDRESSING 4

CMD4:REM PASSES OUTPUT TO
PRINTER

LIST
```

and then, when the listing is complete....

```
PRINT#4:REM PASSES OUTPUT
BACK TO SCREEN
```

by terminating output to the printer using a null **PRINT#** statement. It is important not to forget the last line, as otherwise output, including the READY prompt, continues to go to the printer. The printer is normally device 4, but this can be changed to 5 by a switch on the rear, when the example above will contain 5 instead of 4.

LOAD

Description
Loads and optionally **RUN**s a program.

Syntax
LOAD ["<filename>"][,<device>]
[,<address>]

e.g. LOAD loads the next program on cassette.

100 LOAD A$,8 loads the program from disk, the name of which is set up in A$ by the currently running program, and RUNs it.

Function
This loads a program from a program file on the specified device (usually 1 for cassette and 8 for disk). If executed from within a program, on completion of the **LOAD**, the newly **LOAD**ed program will run, which does not of course apply in direct mode. This allows programs to be loaded serially and run one after the other, or even looped round to run one or a series of programs repeatedly.Obviously in the case of a loop the cassette has to be rewound

and at some point the program must pause to allow this. On **LOAD**, any previous program in memory is lost, whether it is a direct **LOAD** or a **LOAD** from a program. As **MERGE** is not directly available, there is no built in single command way of adding one program to another already in memory (but see '**MERGE**'). The **LOAD**ing of a menu program can allow the selection of other programs e.g.

```
110 IF CH=1 THEN
A$="PROGRAM1"
120 IF CH=2 THEN
A$="PROGRAM2"
130 IF CH=3 THEN
A$="PROGRAM3"
140 LOAD A$,8
```

will load A$ from disk and run it. It is also possible to do this from cassette by omitting the '8' but it may take some time if the required program is some distance down the tape.

Unfortunately if the second program is larger than the first, the system crashes! Yes, it goes horribly wrong because two locations in the BASIC area have not been set properly. These locations are the pointer to the start of BASIC variables at 45 and 46 in both the CBM 64 and VIC. These must therefore be reset by e.g.

```
POKE 45,<number1>:POKE
46,<number2>:CLR
```

where number1 and number2 are found by **PEEK**ing 45 and 46 after writing the program. These numbers determine where the BASIC variable area ought to be. The line above is included as the first line of your program if it is chained (**LOAD**ed from another program) and must be changed whenever the program is modified.

If the filename is not entered, the first file on the cassette is **LOAD**ed or an error message given if the disk is addressed. If the filename is "*" the first file on the disk directory is loaded, with a FILE NOT FOUND error if this is not a program file. If the device is not entered, the cassette is assumed.

The secondary address is not normally used. An address of 1 will, on the CBM 64, cause the program to be loaded at the memory location from which it was saved, rather than automatically in the BASIC area. This could be useful if the BASIC pointers have been moved about to allow some machine code.

A load from cassette followed by an immediate run can be achieved by simply pressing <SHIFT> and <RUN> together.

LOG

Description
Natural logarithm.

Syntax
LOG (<numeric>)
e.g. LOG (10) gives 2.30258509

Function
LOG finds the natural (base e) logarithm (usually abbreviated to log) of a number or expression. This is not the same as the logs shown in school log tables or most slide rules which are to the base 10 and can be obtained as follows:

LOG (A)/LOG (10) returns log base 10 of A

To return from a log to the original number (i.e. antilogarithm usually abreviated to antilog) multiply by the base to the power given by the log. As an example using base 1Ø logs, if the log is 1 and the antilog is wanted this is 1Ø^1 (1Ø to the power of 1) which is 1Ø. If the log is 2 the antilog is 1Ø^2 which is 1ØØ

```
AL=BS^LG where AL is the antilog required
               BS is the log base
               LG is the log
```

(MERGE)

Description
Merges two programs.

Syntax
None.

Description
This facility does not exist in the CBM BASIC. However it is extremely useful to be able to write programs in chunks and then to **MERGE** them. The easy way of doing so is to buy a toolkit such as the VIC 2Ø programmers' aid cartridge, otherwise it can be done as follows:

Write your first program to cassette as a serial file e.g.

```
OPEN 1,1,1,"PROGRAM1":CMD1:
LIST
```

followed by

```
PRINT#1:CLOSE1
```

Then to merge with another program, rewind the cassette and load it using

POKE 19,1 setting the input prompt flag

and finally clear the screen and move down three cursor positions to where the cursor would be after a **PRINT CHR$(19)** and then

```
PRINT CHR$(19):POKE 198,1:
POKE 631,13:POKE 153,1
```

where

PRINT CHR$(19)	clears the screen
POKE 198,1	sets 1 character in keyboard buffer queue
POKE 631,13	sets that character to <RETURN>
POKE 153,1	sets default input from cassette instead of keyboard

thus simulating someone typing into the machine the listing that was saved to cassette. End with a **CLOSE 1** after ignoring the SYNTAX ERROR.

MID$

Description
A string manipulation function extracting or replacing any contiguous part of a string.

Syntax
MID$(<string>,<numeric1>[,<numeric 2>]

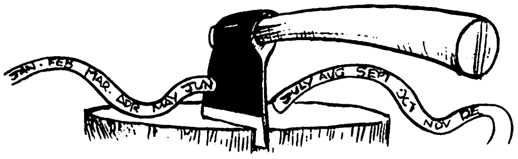
e.g. MID$("JOHN SMITH ESQ",6,5) gives SMITH

Function
MID$ takes the first position of the string to be extracted from the left as numeric1 and extracts numeric2 characters beyond that. If numeric2 is greater than the remaining string length, or is not entered, the rest of the string is taken. Numeric2 must be between Ø and 255 and numeric1 between 1 and 255. No syntax

error is returned if numeric2 is 0 but obviously nothing will be returned by **MID$**.

MID$ can be usefully used in string indexing e.g.

```
10 A$="JANFEBMARAPRMAYJUN
JULAUGSEPOCTNOVDEC"
  :
50 INPUT "MONTH NUMBER";C
  :
100 B$=MID$(A$,C*3-2,3)
110 REM EXTRACTS THE MONTH
USING THE MONTH NO. IN C
```



See also **LEFT$** and **RIGHT$**

NEW

Description
Clears program and deletes variables.

Syntax
NEW.

Function
NEW can be used directly or within a program, in which case it clears everything BASIC including itself. It can therefore be used as a rather primitive security device by clearing a program from memory under certain conditions, although additional line blanking (so that the line containing the **NEW** is not visible) is also required, if the program is not compiled e.g.

```
100 INPUT "DATE (DDMMYY)";
DA$
110 IF VAL(RIGHT$(DA$,2))>84
THEN NEW
```

Programs containing these statements will automatically delete if used beyond 1984. The cassette or disk copy is, of course, not affected.

CBM 64 sprites, machine code and high resolution graphics are not cleared and of course **POKE**s that have been performed remain in effect, so in many cases where these have been used it may be necessary to press <STOP> and <RESTORE> or even switch the machine off and on again

NEXT

Description
Gives the repeat point in a **FOR** loop.

Syntax
NEXT [<counter>],[<counter>]......

Function
NEXT returns the program to the most recent **FOR** statement that has not already been matched with a **NEXT**. If this does not correspond to the **FOR** identifier, a NEXT WITHOUT FOR error occurs i.e. **NEXT** on its own cannot cause this error if there is a **FOR** current as it will automatically match that **FOR** and assume that the identifier in the **FOR** statement is the one intended in the **NEXT**. However, it is safer (but much slower) to use an identifier (e.g. **NEXT I** rather than just **NEXT**) so that the BASIC interpreter can check the syntax and thus your logic.

If the exit condition has been reached, the program will continue by returning to the **FOR** to test it and then skipping to the code directly after the **NEXT**.

See **FOR**.

NOT

Description
Logical **NOT**.

Syntax
NOT <operand>
e.g. A=NOT B

Function
NOT is a unary logical operator, i.e. it works on just one operand, and has two functions.

1. As an operator on an item, in which case the item is converted to an integer between –32768 and 32767 and the bit pattern reversed e.g.

A=NOT 32767 gives A as –32768.
32767 binary is
Ø1111111 11111111
–32768 binary is
1ØØØØØØØ ØØØØØØØØ

The machine interprets the left hand (most significant) bit in an integer as a sign bit. If set, the integer is negative, otherwise positive.

2. As part of an **IF** statement, in effect **IF NOT...THEN...**
e.g.

```
1ØØ IF NOT A$="YES"THEN PRINT
"A$ IS NOT YES"
```

or

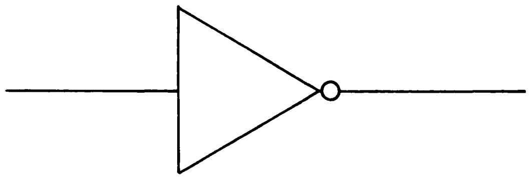
```
1Ø IF NOT (A=B) THEN A=A+1:
   GOTO 1Ø
```

is equivalent to

```
1Ø IFA=B THEN 3Ø
2Ø A=A+1:GOTO 1Ø
3Ø ....
```

In line 1Ø (A=B) evaluates as –1 if true and Ø if false – see Comparisons in Section 1.

NOT is best used purely as a logical operator in the two senses explained above, and not as shorthand for arithmetic operations except on integers, as ILLEGAL QUANTITY errors will ensue if numbers above 32767 are used and decimal numbers will be truncated. **NOT X%** is equivalent to –X%–1 between 32767 and –32768 because the bit pattern in the 16 bit integer is reversed. (The same applies to other numeric variable types provided they contain only integers.)



ON

Description
A multiple switch.

Syntax
ON <variable> {GO TO} <line number>
{GOSUB}
[,<line number>.......
e.g. ON A GOSUB 1000,1100,1200,1300,
1000,1200

Function
ON is a software switch that allows a multiple branch in one instruction and is very useful for table or data driven programs where the path is not determined by program logic but by a table or by data read from a file or input from the screen; e.g. if a screen is displayed as

MAIN MENU

1. LOAD STOCK FILE FROM CASSETTE/DISK
2. SAVE AMENDED FILE TO CASSETTE/DISK
3. ENTER NEW STOCK ITEMS
4. AMEND STOCK AMOUNTS
5. REVIEW
6. REPORTS

SELECT ITEM REQUIRED ?

then code to perform the relevant functions could be selected as below (repeating the code that produces the last line above)

```
10 INPUT "SELECT FUNCTION
REQUIRED";MN$
20 ON VAL(MN$) GOTO 100,200,
300,400,500,600
30 PRINT "INVALID CHOICE":
GOTO 10
 :
 :
```

or from a file...

```
10 GET#1,MN
20 ON MN GOTO 100,200,500,100,
   300,400,100
30 PRINT "ERROR ON INPUT
   TAPE"
40 END
 :
 :
```

If the variable (e.g. MN) is 0 or greater than the highest number in the list, the program will continue with the next statement which displays an error message and stops. (It could return to the selection with a **GOTO**.) If it is greater than 255 or negative an ILLEGAL QUANTITY error occurs. If it is not an integer the fractional part is ignored.

ON replaces a whole series of **IF** statements provided that the selection criteria can be converted to a sequential series of numbers e.g. if the reply to a menu was A B C or D in MN$.

MAIN MENU

A. LOAD STOCK FILE FROM CASSETTE/DISK

B. SAVE AMENDED FILE TO CASSETTE/DISK

C. ENTER NEW STOCK ITEMS

D. AMEND STOCK AMOUNTS

etc

```
110 N=ASC(MN$)-64
120 ON N GOTO 200,300,400,500
130 PRINT "INVALID REPLY".......
```

or even

FILE MENU

C. CREATE FILE

K. KILL FILE

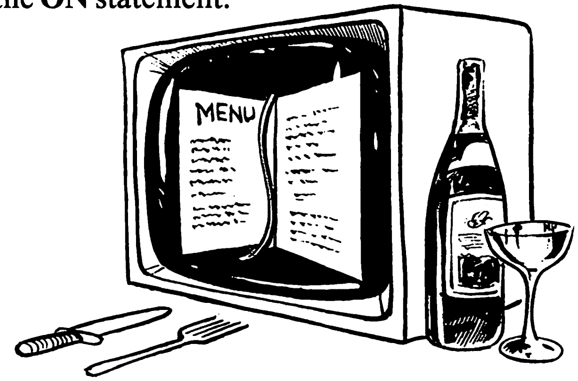
A. AMEND FILE

```
110 N=ASC(MN$)-64
120 ON N GOTO 300,130,130,
130,100,130,130,130,130,130,200
130 PRINT "INVALID REPLY"......
```

will handle a reply of C, K or A

Unrelated variables and complex conditions cannot be handled and in these cases **IF** must be used or a table of values set up.

Although in general programming terms the use of **GOTO** is not recommended, in the case of **ON** it should normally be used rather than **GOSUB** as otherwise invalid entries cannot easily be checked in the statement following the **ON** statement.



OPEN

Description
Opens files or channels to peripherals.

Syntax
OPEN <file number>,[<device>
[,<operation>][,"<file name>
[,<file type>][,<mode>]"]

e.g. OPEN 1,1,0,"DATA"opens a file on cassette named DATA in READ mode and gives it a number 1.

Function
OPEN sets up a channel for the transfer of information to or from the computer. This can then be used by **CMD**, **GET#**, **INPUT#** and **PRINT#** statements until it is closed with a **CLOSE**.

The file number is the number that all other file handling statements, such as the ones above, will use to identify it. It should be between 1 and 127. Numbers over 127 can be used but were intended for I/O use and not as files. A good convention is to use the same file numbers for devices as the device number for cassette screen and printer and then numbers from 8 upwards for disk files.

The device can be 1 for the supplied cassette, 2 for a second cassette (which must be Commodore or Commodore compatible as unlike other home computers ordinary cassette players are not usable), 4 or 5 for the printer depending on a selector switch on the printer, and 8 upwards for disk drives. No entry defaults to 1 (the cassette).

The operation indicates what the file will be used for:

0 = OPEN for reading from cassette – this is the value if nothing is entered.

1 = OPEN for writing to cassette without end of tape (or file) marker.

2 = OPEN for writing with end of tape marker.
(The end of tape (or file) marker can be used to prevent accidentally reading past the end of the data on a file on a subsequent read.)

2–14 = secondary addresses for use with the disk unit.

The file name is a string of between 1 and 16 characters which is the name that will be set up on the disk or cassette when writing, or searched for when reading.

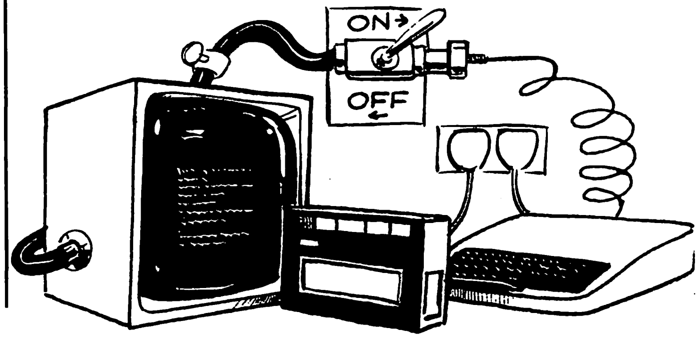
The file type is sequential (SEQ) if not entered. The other types are relative (REL), random which is only applicable to disk files or program (PRG) which is used by the system during **LOAD** and **SAVE** etc.

The file mode is only used for disk and can be R for read (the default if no mode is entered) or W for write.

All this may seem rather complicated, and for someone unused to microcomputer files on disk it can be rather difficult. Careful study of the disk manual and an ability to understand file handling concepts is required and is beyond the scope of this book. It is in fact all there in the disk manual but will require some perseverance. However for cassette and printer use it is not too much of a problem:

OPEN 1,1,0,"DATA" for read and **OPEN 1,1,1,"DATA"** for write are all that is required for the cassette. **OPEN 4,4** opens a normal printer after which information can be sent to the screen using **CMD** or **PRINT#4**. See **LIST** for the procedure needed to list a program to the printer.

See also **CLOSE, CMD, PRINT#, GET#, INPUT#**.



OR

Description
Logical **OR** operator.

Syntax
<operand> **OR** <operand>

e.g. IF (A=1) OR (A=2) THEN...(brackets are optional)

Function

OR is a binary function, i.e. it works between two operands and has two functions:

1. As part of a logical test in an **IF** statement where **OR** indicates that either condition can be satisfied to satisfy the **IF** e.g.

```
IF A=B OR A=C THEN 5Ø.

IF A%=1 OR A%=2 OR A%=3 THEN 5Ø
```

will go to line 5Ø for any integer between 1 and 3 inclusive.

```
1Ø INPUT "MENU NUMBER";MN%
2Ø IF MN%<Ø OR MN%>5 THEN 1ØØ
```

will check that a menu entry lies between 1 and 5. Line 1ØØ is the start of the error routine. See **ON** for a description of menu handling and some examples. **ON** can be clumsy where the spread of possible replies is too great and **OR** is therefore a possible alternative as is a series of **IF**s. Beware that occassionally this **OR** test does not work due to a bug in BASIC

2. As a logical function on binary numbers with the following truth table which applies to each bit in the integer part of a BASIC variable:

X	Y	X OR Y
1	1	1
1	Ø	1
Ø	1	1
Ø	Ø	Ø

so that **A=8Ø OR 48** will give 64+32+16 = 112

```
   128 64 32 16 8 4 2 1 – decimal values
                           of bits
     Ø  1  Ø  1 Ø Ø Ø Ø     8Ø
  OR Ø  Ø  1  1 Ø Ø Ø Ø     48
     Ø  1  1  1 Ø Ø Ø Ø     112
```

The maximum size of binary number which can be handled in this way is 16 bits or two 8 bit bytes. This is the size of a BASIC integer variable and in decimal is between –32768 and 32767 (being 1ØØØØØØØ ØØØØØØØØ and Ø1111111 11111111 with decimal zero being ØØØØØØØØ ØØØØØØØØ of course). All numbers have to be expressed in decimal as unfortunately the VIC and CBM 64 (in common with most BASICs) have no handling of binary numbers except through decimal numbers.

There are many different ways of carrying out branching comparisons and binary logical functions. Once your design has clearly stated the logic required, a truth table should be set up to show what is required. This is then implemented with **OR NOT AND** statements as required, in the simplest fashion. Equivalent statements abound:

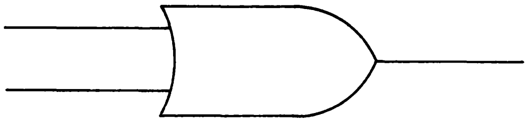
```
(a) IF A%=Ø OR A%=1 OR A%=2 OR
    A%=3 THEN...
(b) IF A%<=Ø AND A%>=3 THEN...
(c) IF NOT(A%<Ø OR A%>3)
    THEN...
```

are all equivalent, and the one used should be the one that is clearest to understand and reflects the design. A choice of several unrelated numbers (or strings) requires format (a), a range requires format (b). It is difficult to think of circumstances in which format (c) would be preferable.

It is also easy to write incorrect logic or even meaningless logic:

```
IF A<>4 OR A<>5 THEN....
```

is always true but the computer is not smart enough to recognise this and give an error message, so you have to do it by checking your code by hand or when testing the flow of logic during debugging.



See also **AND, NOT**.

PEEK

Description
Examines a memory location.

Syntax
PEEK (<location>)
e.g. PEEK (1Ø24) gets the contents of the first screen location on a CBM 64.
PEEK (768Ø) gets the same for an unexpanded VIC.

Function
If **PEEK** is used on a valid memory location, the value of the bit pattern of the 8 bit byte is found and expressed as a decimal number. A location of less than Ø or more than 65535 causes the error ILLEGAL QUANTITY to appear. If on the VIC the memory location is not valid (no memory exists at this location) an undefined value will be returned, but no error message, so it is important to check that the memory you have and your **PEEK**s and **POKE**s are consistent. **PEEK** and **POKE** are the BASIC way of direct communication with machine memory and therefore they are extremely varied in usage, including being able to get into and modify the BASIC operating system. This is beyond the scope of this book. Common uses will be found in your user manual, so they are not repeated here. Remember that <location> can be an expression, so indexing and logical operations are possible:

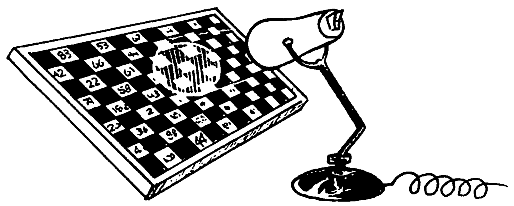
```
PEEK (1Ø24+(V-1)*4Ø+(H-1))
```

gives the screen contents at location H position across the screen and V vertical lines down the screen for the CBM 64.

It is sometimes convenient to show location numbers in 2 bytes as this shows more clearly where they are in memory. For instance upper case characters on the CBM 64 start at 53248 or 2Ø8*256+Ø, this latter being easier to remember and use for offsets to the various characters in the character set. The formula for **PEEK**ing a 16 bit address is

```
AD=PEEK(X)+PEEK(X+1)*256
```

for two adjacent locations with the least significant or low order byte first.



See also **GET#** which can read from the screen, and **WAIT** which waits for a location to change.

POKE

Description
Sets the contents of a memory location.

Syntax
POKE <location>,<integer>
e.g. POKE 1Ø24,1 sets the character A into the top left hand corner of the CBM 64 screen.
POKE 768Ø,1 sets the character A into the top left hand corner of the VIC screen.

Function
POKE is the complement of **PEEK**, setting any 8 bit location in memory. The location follows the same rules as for **PEEK**. The integer must evaluate to between Ø and 255 or the ILLEGAL QUANTITY error appears. This is because an 8 bit location can only contain numbers between Ø and 255.

POKEing values into ROM or non-existent memory locations will obviously not work, but there's no error message so take care! Also as **POKE** is not restricted to any part of memory, an ill advised **POKE** or one in a runaway loop (see **FOR**) can crash the operating system or cause other unpredictable effects, with possible loss of program. If your program contains **POKE**s, it is therefore prudent to **SAVE** it after typing it in and each time substantial modifications are made.

POKEs can be used to set up screens (normal or graphic), operate the sound system or even to set up a few lines of machine code. Most uses of **POKE** are described adequately in your CBM 64 or VIC manual, but for machine code a good understanding of the machine hardware and operating system is required to achieve anything significant, together with some programming expertise of course. The CBM 64 and VIC are a little unusual in the number of intrinsic functions carried out by **POKE** instead of say **SOUND** or **COLOUR** commands which do not exist in this BASIC.

To set up machine code in BASIC, work out a start address and the code statements required and then load them with a routine such as

```
1ØØ FOR I=1 TO 1Ø
11Ø READ N:POKE (BS+I),N:NEXT I
12Ø DATA........
```

where 1Ø code statements held in **DATA** are to be entered, starting at address BS. The **DATA** statements have to be decimal which takes some working out!

POKE can be used in place of **PRINT**, if you don't want to disturb the cursor position while putting something on the screen. If V is the vertical and H is the horizontal position required a formula to do this would be

```
POKE (1Ø24+(V-1)*4Ø+(H-1)),1 for
the CBM 64
POKE (768Ø+(V-1)*22+(H-1)),1 for
the unexpanded VIC
```

for the character A in this example, and a similar expression for the colour. The expression could of course be set up by, say A=V*22+H on the previous line.

Try working out the same in **PRINT** – much more complicated for just one character. Normal text and header output is better handled by **PRINT**.

The general formula for **POKE**ing in a 16 bit number to two 8 bit bytes is

```
POKE X,NO-INT(NO/256)*256:
```

```
POKE X+1,INT(NO/256)
```

where X is the least significant part of the word.

POS

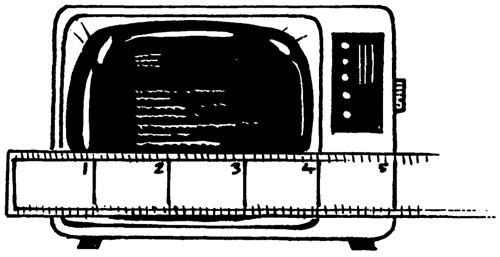
Description
Gives the cursor position.

Syntax
POS (<dummy>)
e.g. POS(0)

Function
POS returns the position of the cursor in a given logical line, i.e. between 0 and 79, where 0 to 39 is on the first screen line (64), 40–79 is on the second screen line, and similarly for the VIC. The dummy is ignored. As an example POS(0) returning a value of 20 is directly above a value of 60 in a line of information that spreads over 2 lines of the screen:

```
110 IF POS(0)+LEN(WD$)<39 THEN
      PRINT WD$" ";:INPUT#1,
      WD$:GOTO 110
120 PRINT:GOTO110
```

will prevent words being read from cassette file from being split between lines.



PRINT

Description
Outputs information to a specified device.

Syntax
PRINT [<variable>[{;}]].......
{,}

e.g. PRINT A$B$;
concatenates and prints A$ and B$ and does not move to the next line.

Function
PRINT is an extremely versatile statement, so its function can be broken down as follows:

1. *Detailed Syntax*
PRINT on its own produces a new line.

PRINT <variable> causes the contents of the variable to be displayed on the output device, followed by a new line. The variable can be any string or expression. Some variables are specific to **PRINT**. These are **TAB** and **SPC**.

A comma causes formatting similar to tabulation on a typewriter, the tab positions being 10 apart from 10 to 70. A semi-colon causes the next item or **PRINT** statement to follow directly on the same line.

If neither a semi-colon nor a comma is used, items within this **PRINT** statement are concatenated on the same line, but the next **PRINT** statement follows on the next line.

2. *Formatting of Output*
This varies slightly depending on the device to which the output is being sent. This device is not specified in the **PRINT** statement, and will be the screen unless a **CMD** statement has been executed directing all **PRINT** statements to another device

Numeric items are preceded by a space or minus sign and followed by a space. Trailing zeros are removed e.g. 25.1Ø becomes 25.1 and 25.ØØ becomes 25. Literal strings (e.g. "STRING ") are printed exactly as shown with a few special exceptions, but note that **SPC**(X) is not quite the same as printing X spaces since **SPC** does not delete information previously present in the spaced out area. The exceptions above are " (quotes) which terminate a string, <RETURN> and <SHIFT/RETURN>. Cursor control characters can be put inside quotes and appear as shown in Appendix B when typed in and will cause the relevant cursor actions when **PRINT**ed.

Colour controls within strings cause the colour of the succeeding character to change when **PRINT**ed. Within the quotes they appear as various graphic characters as shown in your VIC/CBM 64 manual and also in Appendix B (for the main colours).

The <INST/DEL> keys perform their normal functions within quotes, so that the reverse T for **DEL** following **INST** will appear and will have that effect in printing e.g.

```
PRINT "FORMINGTTTAT
```

will appear as FORMAT. It is best to avoid this feature if possible as **LIST**ing will not show the full line and thus editing is tricky.

Some other fiddling about with the information within quotes is possible but equally tricky. For instance spaces are left for special characters, the line is completed with <RETURN> and the cursor controls are used to get back into the line.

Experimentation is the only way to really understand these features.

To avoid all the above drama, use should be made of **CHR$** to encode special characters, e.g. to switch the display to lower case use

```
PRINT CHR$(14)......
```

Note that if the output is to the printer **CHR$(17)** must be used instead and has to be repeated at the start of every line or it goes back into upper case mode. **CHR$(14)** on the printer is double width mode. Other **CHR$** characters on the printer retain their effect until cancelled e.g. by **PRINT CHR$(15).**

POKE may also be used occasionally (q.v.) and **PRINT#** may be used instead of **CMD** and **PRINT** when writing to the printer. This is often the preferred mode as then repeated use of the **CMD** statement to switch control is avoided.

PRINT#

Description
Prints directly to a file or device.

Syntax
PRINT# <file number>,[<variable>[{;}]]
{,}

e.g. PRINT#1,A$

Function
PRINT# is very similar to **PRINT**, but is used to write data to a logical file (which may be output to the printer direct).

The comma, semi-colon or blank are all interpreted as input separators but are not passed through as characters or separators to the file unless within quotes when they are treated like any other character; i.e. items are written one after the other without separators. Commas cause spaces to be written to the file after each variable or group of variables between commas to make its total length up to 1Ø. At the end of a **PRINT#** statement, if no punctuation exists, a carriage return and line feed are output. Any punctuation by comma or semi-colon causes the next **PRINT** statement to put characters in the next character position, again without separators. A line can be up to 255 characters long. To separate the variables on file (cassette or disk), **CHR$(13)** should be used instead of <RETURN>:

```
110 CR$=CHR$(13)
120 PRINT#1,
    A$CR$B$CR$C$CR$...
```

Before a **PRINT#** can be used an **OPEN** statement must have been executed for the file or device. It is possible to **OPEN** the screen for output as with any other device, enabling the same code to be used for printing both to screen and printer. A **CLOSE** must be executed before program end or the file will be left incomplete.

Example – to compact and store a list of names:

```
10 OPEN1,1,1,"NAME":CR$=
CHR$(13)
20 PRINT "ENTER NAMES; ENTER *
TO COMPLETE FORENAMES IF < 3"
30 PRINT "SURNAME,
FORENAMES, TO FINISH ENTER *
IN SURNAME"
40 INPUT S$,F1$,F2$,F3$
50 IF S$="*"THEN CLOSE1:END
60 PRINT#1,S$CR$F1$
70 IF F1$="*"THEN 30
80 PRINT#1,F2$
90 IF F2$="*"THEN 30
100 PRINT#1,F3$:GOTO 30
```

READ

Description
Reads from a DATA statement.

Syntax
READ <variable>[,<variable>].....

Function
Information is transferred from the **DATA** statements as if they were a sequential file. The first **READ** picks up the first **DATA** line and then works its way through the **DATA** items until all variables specified have been filled. The next **READ** follows on where the previous one left off until a **RESTORE** statement resets the data pointer to the start.

OUT OF DATA appears if the **READ** tries to go beyond the end of the **DATA** and SYNTAX ERROR appears if there is a type mis–match. The line identified is the line containing the **DATA** item. **READ** can be used to simulate data input from a file when developing a program, or for fixed patterns such as characters or music. It can also be used as a fixed table of values to control a program e.g.

```
110 READ CL%
120 ON CL% GOTO 100,200,
300,400,500
```

DATA has the advantage over files in that it is fast, with no waiting for file buffers to be loaded, and convenient, as it is already in the program. However, for large amounts of **DATA**, memory becomes a problem and of course there is no easy way of reorganising **DATA**, which can only be done by careful editing of the program.

Field structures cannot easily be shown in complex cases and the omission of one item in a sequence will throw out the organisation of the data. This can be avoided in a file by writing a 'data take-on program' which guards against the user making such errors:

```
110 READ DT1: IF DT1 > 127 OR
DT1=0 THEN 300:REM ERROR
110 READ DT2: IF DT2=0 THEN 300
  :               :
```

in a loop reading a series of values of character codes (DT1) and their positions on a line (DT2).

INPUT# OR **GET#** should almost always be used instead of **DATA**. (In most other computer languages **DATA** or its equivalent does not exist.) The effect of **READ** can better be achieved for tables by **DIM**ensioning a number of arrays and reading information into them from files by **GET#** statements. A "data" pointer then can be set to anywhere within the arrays and not just to the beginning with **RESTORE**. Initial values can be set with data statements, and read into an array after which they can be processed or modified at will e.g.

```
110 FOR I=1 TO 10
120 READ DT:DT(I)=DT
130 NEXT
```

or from a file:

```
110 FOR I=1 TO 10
120 GET#1,DT:DT(I)=DT
130 NEXT
```

not forgetting to open and close the file as required.

See also **DATA, RESTORE**

REM

Description
Comment statement.

Syntax
REM [<text>]

Function
The **REM** statement itself has no function as far as the computer is concerned, although its line number can be used as target for a **GOTO** or **GOSUB** statement. Its purpose is to allow the programmer to note important details of the program, or headings for subroutines or other distinctive sections of code. In any program, **REM** is a very useful reminder of what has been done and why, or as a heading to identify a section of the program. In Commodore BASIC **REM** is particularly important as it is difficult to attach meanings to variables which can only (safely) be two characters. Thus without **REM**, programs tend to resemble a jungle of indecipherable code.

The text of a **REM** statement can be any character except <RETURN> which terminates the line.

If only blank lines are required for formatting a listing, a lone colon e.g. 11Ø: will serve instead of **REM**, and will not cause a SYNTAX ERROR! The same applies after a **GOTO** as anything thereafter is never accessed by the program, but this is not recommended as changes to the program (**GOSUB** instead of **GOTO**) may cause problems.

REM statements should be used at the beginning of a program to give general information such as title and date last amended and a section should then be included to identify the variables e.g.

```
REM L=LENGTH W=WIDTH
H=HEIGHT V=VOLUME........
```

Unfortunately **REMs** do occupy space and marginally slow a program down, so if you are short of space transfer your **REM** statements to a piece of paper kept with the program. Beware of long programs without reasonable use of **REMs** which are often impossible to finish. Large well written commercial programs are heavily commented, and it is worth noting that if you are writing large programs it is worthwhile getting a compiler. This will compact your code and remove all **REM** statements from the running version while leaving your original ('source') code intact.

RESTORE

Description
Resets the **READ** pointer to the first DATA item.

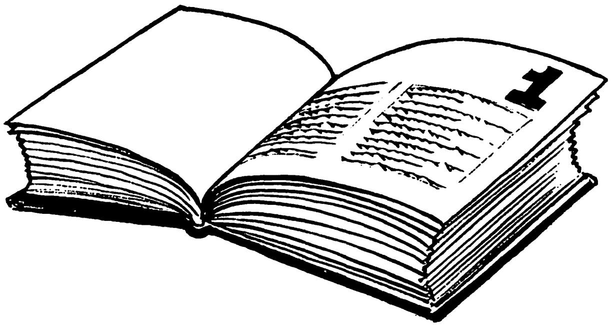
Syntax
RESTORE

Function
Each **READ** processes further **DATA** statements until a **RESTORE** occurs, after which the **READ** picks up the first **DATA** statement again. **RESTORE** might be used as part of a loop to allow a musical program to be played repeatedly or repeat information on a screen.

Unlike many dialects of BASIC, CBM computers do not have a **RESTORE** <line number> function, so to return to a given **DATA** statement (not being the first one) requires a combination of **RESTORE** and dummy **READS**:

```
11Ø RESTORE
12Ø FOR N=1 TO 1ØØ:READ DM$:
NEXTN
```

to reach item no. 1Ø1



See also **READ, DATA**

RETURN

Description
Terminates a subroutine.

Syntax
RETURN

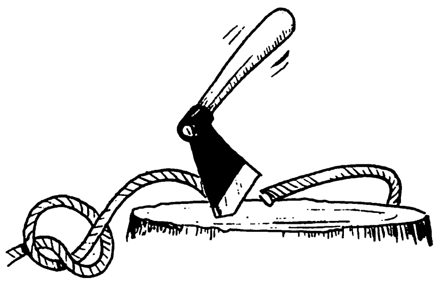
Function
Every subroutine must be terminated by a **RETURN** which transfers control to the statement following the **GOSUB** statement. Note that failure to put a **RETURN** at the right place will simply cause the program to run wild through any code following that point. No SYNTAX ERROR can appear as the computer does not know when to expect a **RETURN**. One should be vigilant over this problem to avoid having painful debugging sessions. See also **GOSUB**.

RIGHT$

Description
A string manipulation function which extracts part of a string starting from the right.

Syntax
RIGHT$(<string>,<integer>)
e.g. RIGHT$("JOHN SMITH",5) GIVES SMITH

Function
RIGHT$** takes the rightmost <integer> characters of the string. The integer must evaluate to between Ø and 255. This is useful in truncation or as part of a string analysis routine and quite complex syntax can be used here with good effect. For examples see **LEFT$ and **MID$** and also **INT** which is valuable for rounding and truncating numerics and is easier to use than the string functions under these circumstances.



RND

Description
A pseudo random number generator.

Syntax
RND (<numeric>)
e.g. RND(1)

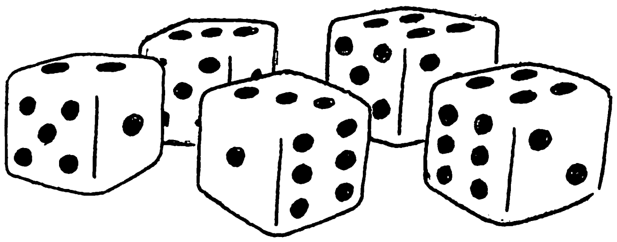
Function
The **RND** function is useful to create a floating point number between Ø and 1. The numeric is a dummy when positive and generates the numbers in a fixed repeatable sequence. To start such a sequence a negative number should be used to provide the seed for the generator, in other words to restart the generator at the beginning of a known pseudo random sequence. The sequence of random numbers generated depends on the negative numeric used to set up the sequence. The negative number **RND** does not itself generate a random

number that can be used in a sequence. If the numeric is zero there is no fixed repeatable sequence. If a known sequence is not required, it is possible to use **RND** without seeding e.g.

```
10 GET A$:IF A$=""THEN 10
20 PRINT ""
30 FOR N=1 TO 4:PRINT
   INT(RND(1)*6+1):NEXT
40 GOTO 10
```

simulates throwing 4 dice on pressing any key.

As can be seen from the example, to get a maximum random number of 6 requires that 1 is added to RND(1)*6 as the random number generator will never produce a value of exactly 1 and so INT(RND(1)*6) will be between 0 and 5 instead of 1 and 6 as required.



RUN

Description
Starts a program.

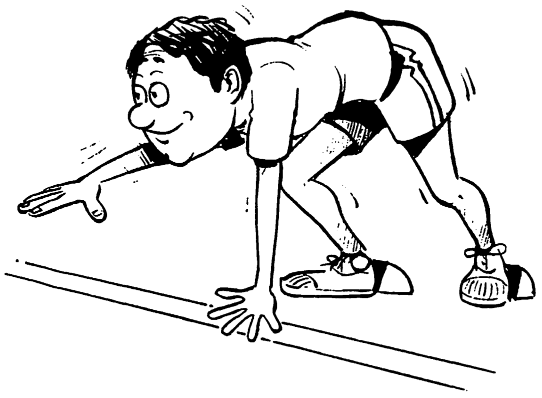
Syntax
RUN [<line number>]
e.g. RUN

Function
RUN is normally used directly from the keyboard to start a program but can be run from within a program, when its effect is rather like a **GOTO** except that it implies a **CLR** statement clearing not only variables and arrays, but loop counters and subroutine pointers, just as if the program had been loaded and started for the first time. If a line number is specified it starts the program from that line which must exist even if only as a **REM** or lone colon, otherwise the message UNDEF'D STATEMENT appears.

```
60 IF CU$="NEW"THEN RUN 100
70 IF CU$<>"NEW"THEN RUN 200
```

re–initialises from one of two starting points. Be careful of **DIM**ensioned arrays as any array dimension statements are cleared by typing **RUN**.

Don't use **RUN** when debugging using **STOP** statements, **CONT** should be used.



SAVE

Description
Saves a program.

Syntax
SAVE [<[@0:]program name>][,<device number>][,<address>]
e.g. SAVE "PROGRAM",8

saves a program named "PROGRAM" to disk, PROGRAM being currently not on disk.

Function
SAVE stores a program to cassette or disk, giving it any name up to 10 characters long. The '@0' is not part of the name but is required if the original program on disk under the same name is to be overwritten. The device number is 1 (cassette) if nothing is entered. If 8 is entered, the program is saved to the disk designated on device 8 (the usual device number). The address, if used, has only 3 values which are as follows:

1. The cassette/disk copy being made will be loaded back at the same place in memory where it currently resides, when **LOAD**ed again.

2. An end of tape marker is put on tape.

3. Both functions 1 and 2 are carried out.

If a disk is used, a filename must be given, as the disk is not a serial device like a cassette. The **SAVE**d program is put on to a convenient space on the disk and the disk programs are not in any particular order. On cassette a filename need not be given, when the program will be saved without a name. However, it is sensible to give it a name so that you can check when loading that you have the right one. Beware of the fact that the cassette can load on a part match, so **LOAD P** will load the first program whose name begins with P.

Programs on cassette are **SAVE**d one after the other in the order of the **SAVE**s. **SAVE** can be used from within a program but if in main code this can occupy a lot of time during debugging if long programs need to be **SAVE**d to tape every time a small bug is corrected. **SAVE**ing a long program can take over 10 minutes. An exception might be made for a program containing **POKE**s or machine code calls SYS or USR which might wipe out or corrupt the operating system, e.g.

```
10 SAVE "POKEPROG"
20 DEF..........
   :
```

saves the program before any code is executed.

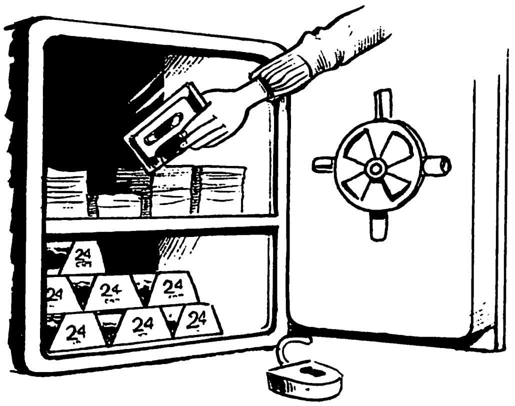
A better method would be:

```
1 GOTO 10
2 SAVE "PROGRAM"
3 STOP
4 VERIFY "PROGRAM"
5 STOP
10 REM START OF PROGRAM
```

where **RUN** 2 will **SAVE** the program, and, after the cassette has been rewound, **CONT** will **VERIFY** it and **CONT** again will run it.

A good discipline is to mark all changes on your listing as you go along, or on a piece of paper if you have no printer, so that in case of disaster you know exactly what has been done, and also to save when the listing becomes difficult to read or you stop for a break.

SAVE all important or lengthy programs on alternate cassettes so that damage or corruption on one cassette does not cause loss of all your work.



SGN

Description
Logical test of the sign of a number.

Syntax
SGN (<numeric>)
e.g. SGN (A–1)

Function
If the numeric evaluates to a positive number the SGN is 1, if it is Ø, Ø and if negative then –1. An example is

```
50 ON SGN(A)+2 GOSUB1000,
2000,3000
```

which is a neat way of branching three ways, especially as **ELSE** does not exist. This could be used where a money amount is printed in the debit column if negative, the credit column if positive or not printed at all if zero.

SIN

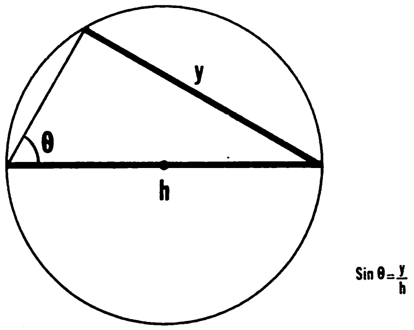
Description
Trigonometric sine function, giving the ratio of the side opposite and the hypotenuse in a right angled triangle.

Syntax
SIN (<numeric>)
e.g. SIN (1) gives Ø.84147

Function
The sine of an angle (in radians) is produced. See also **TAN**, **COS** and the table of other trigonometric functions in your user manual. Example:

```
SIN(Π/4)
```

gives the sine of 45 degrees = Ø.7Ø71Ø6781



SPC

Description
Produces spaces in a **PRINT** statement.

Syntax
SPC(<numeric>)
e.g. SPC(5) moves the cursor 5 spaces to the right

Function
SPC steps the cursor along, without printing, by the number of spaces specified. On the screen this leaves anything previously on the screen unchanged, but obviously on other devices it writes spaces. Line overflow is prevented in all cases by automatic <RETURN>s where required. The numeric must evaluate to between 1 and 255 (or 254 for disk files) e.g. in,

```
    PRINT SPC(I*4Ø+J)
```

will move the **PRINT** position down I lines and along J spaces if the expression is less than 255 (CBM 64).

PRINT "   " actually prints spaces rather than skipping them and **TAB** gets to a predicted position beyond the existing cursor position thus often avoiding the need to recount spaces every time a program changes slightly. See also **POKE**.

SQR

Description
Square root function.

Syntax
SQR (<numeric>)
e.g. SQR(4) gives 2

Function
Gives the square root of a number or expression. The computer cannot handle imaginary numbers, so the numeric must not be negative (error ILLEGAL QUANTITY appears).

STATUS

Description
Variable holding the status of the file most recently operated on.

Syntax
ST

Function
ST is zero for an ordinary I/O operation. Bits are set in the 8 bit **ST** word for any conditions that arise, as follows:

ST (Bit)	Cassette	Serial I/O	Disk
Ø		Timeout – write	
1		Timeout – read	
2	Short block		
3	Long block		
4	Non-recoverable read error/ mismatch on LOAD/ VERIFY		
5	Checksum error.		
6	End of file	End of input	End of file
7	End of tape	Device not present	

e.g.

```
100 IF ST=64 THEN 1ØØØ
     :        :
     :        :
1ØØØ PRINT "END OF FILE – NO
ERRORS"
```

tests for end of file without other error conditions. 64 is binary 01000000 representing the end of file condition.

STEP

Description
Defines amount of step in a **FOR** loop.

Syntax
See **FOR.**

Function
See **FOR**. Note that if **STEP** is not explicitly coded BASIC assumes a **STEP** of 1. In backward counting loops therefore, **STEP** has to be specified.

STOP

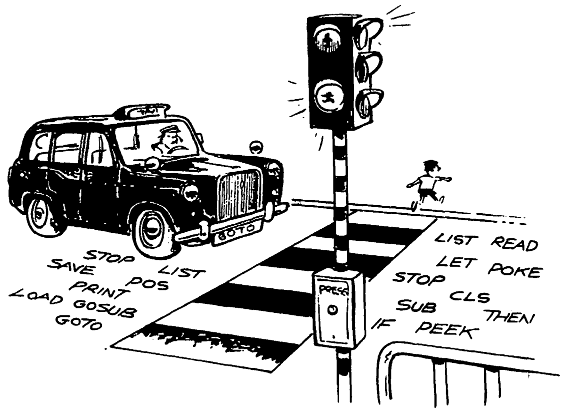
Description
Halts a BASIC program.

Syntax
STOP.

Function
STOP simulates a depression of the <STOP> key. The BASIC program waits and all its variables are available to examine or change. The message given by the system is BREAK IN LINE... and the line number followed by READY as the machine returns to command mode. To restart type **CONT** or to skip to another part of the program type **GOTO** <line number>. The program then resumes without resetting stacks or variables.

The **STOP** function is extremely useful in finding the bugs in a program. You can check if a program follows a given path by placing **STOPs** in it and can check the variables within the program to see if they are at the expected values.

This function is very similar to **END** except that the **END** does not produce a BREAK IN LINE .... error message.



STR$

Description
Converts a numeric to a string.

Syntax
STR$ (<numeric>)

Function
Evaluates a numeric or numeric expression as if it were to be **PRINT**ed and converts each numeric character to its **ASCII** character equivalent. The first character is always a space or negative sign e.g.

```
PRINT STR$(4.5E5)
```

gives " 450000" (length 7)

This function is not often used except during disk handling as the work is considerable, chiefly because one often needs to get an exact match between the strings and the expected results when these are converted back to numerics. For example 45.ØØ is converted to 45 by **VAL**, while 45.Ø1 remains as 45.Ø1. However see the number checking routine in Section 3.

SYS

Description
Starts a machine code subroutine.

Syntax
SYS <location>
e.g. SYS 828 starts a machine code program in the cassette buffer, starting at decimal 828.

Function
The safety of BASIC is left behind, all commands must be programmed in machine language using an assembler or a series of **POKE**s in the BASIC program. Good luck, but watch out as any error may sink you! Don't forget to end your machine code on an **RTS** if you want it to come back to the BASIC program.

It is beyond the scope of this book to describe machine level programming, usually required to obtain speed or special features of the hardware. It is worth considering that a BASIC compiler may achieve the same effect, with far less effort.

SYS should be used in preference to the other BASIC machine code call, **USR**, which is more difficult to use without any real advantages.

TAB

Description
Moves the cursor to a defined position in the logical line.

Syntax
TAB (<numeric>)
e.g. TAB (35)

Function
TAB acts in the same way as a typewriter **TAB** but can run on beyond the logical line length of 8Ø characters, up to 255 positions in total (from the start of the line). E.g.

```
110 PRINT "MAR"TAB(10) "APR"
TAB(20) "MAY"TAB(30)"JUNE"
120 FOR N=1 TO 5
130 PRINT S$(N,1)TAB(10)
S$(N,2)TAB(20) S$(N,3)TAB(30)
S$(N,4)
150 NEXT
```

prints 5 sets of (say) monthly sales figures (held

in a two dimensional string array S$ as equal length strings) in neat columns.
Or on the printer:

```
110 PRINT "MAR"TAB(7)"APR"
TAB(7)"MAY"TAB(7)......etc
```

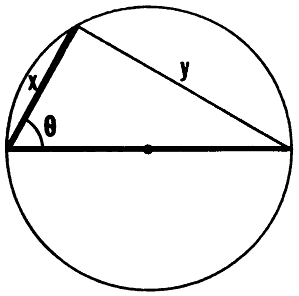
produces the same effect, from which can be seen that **TAB** works like **SPC** for the printer.

TAN

Description
Trigonometric tangent function being the result of the side opposite to the angle divided by the side adjacent to the angle in any right angled triangle.

Syntax
TAN (<numeric>)
e.g. TAN (∏/4)=1 (actually comes out as .9 recurring)

Function
The tangent of an angle (in radians) is produced. See also **SIN**, **COS** and the table of other trigonometric functions given in your user manual. As the tangent, unlike **SIN** or **COS** can approach infinity, an error DIVISION BY ZERO will appear if the



$\mathrm{Tan}\,\theta = \frac{y}{x}$

tangent is too close to ∏/2 or a multiple thereof. (I.e. BASIC cannot handle infinite numbers, so a test must be incorporated to bypass **TAN** and give an answer of INFINITE if the tangent of ∏/2, is expected to be requested).

TIME

Description
Reads an internal clock.

Syntax
TI or **TI$.**

Function
The function **TI** starts at 0 on power up and can be reset at any time using **TI$** (trying to reset with TI=0 gives a syntax error). e.g.

```
TI$="000000"
```

It counts time accurately (even if it's on a 50 Hz supply) in 1/60 second units (except when cassette Input or Output is taking place) as a pure count in **TI** but as a string of six numerics of the format "HHMMSS"in **TI$**. It can usefully be used as a keyboard timer e.g.

```
10 TI$="000000"
20 GET A$:IF TI<10*60 AND
A$=""THEN 20
30 IF A$=""THEN PRINT "MISSED-
10 SECONDS UP":END
40 PRINT "YOU TOOK "TI/60
"SECONDS":GOTO 10
```

As an illustrative program the CLOCK program below shows how to set up and display hours minutes and seconds. METRONOME gives a method of creating a fixed time interval.

```
1 REM CLOCK
2 POKE 53281,1
3 PRINT "[illegible]"TAB(15);"______"
5 PRINT "[illegible]"TAB(15);"|      !"
7 PRINT "[illegible]"TAB(15);"——————"
10 PRINT "[illegible]";;AB(16);LEFT$(TI$,2);":";
    MID$(TII$,,3,2)":"RIGHT$(TI$,2)
12 POKE 53280,INT(RND(1)*16)+1
20 T$=TI$
30 IF T$=TI$ THEN 30
40 GOTO 10
```

Printer in lower case mode.

```
100 rem metronome - vic 20
110 vl=36878:s1=36874:Poke vl,15:ti$="000000"
120 input "[illegible]beats/min";bt$
130 Print "[illegible]enter c to change              e to end
    "
140 bt=val(bt$):if bt=0 then Print "0 is too slow!
    ":goto 110
150 mt%=60*60/bt:rem Pulses/sec * secs / no. beats
     Per min
160 get ky$:if ky$="e" then 210
170 if ky$="c" then 120
180 if mt%>ti then 160:rem wait for clock tick or
    command
190 Poke s1,128:Poke s1,0
200 ti$="000000":goto 160
210 Poke s1,0:Poke vl,0:end

ready.
```

USR

Description
Starts a machine code routine.

Syntax
USR(<numeric>)
  e.g. X=USR(A*2+4)

Function
USR calls a subroutine in the location pointed to by memory locations 1 and 2 (VIC) or 785 and 786 (CBM 64). This must be set up by **POKE**s before **USR** is called. The numeric is stored in the floating point accumulator at the start of the subroutine and the result of the machine code routine is left in 97 for the BASIC program when control is returned with an **RTS** machine language statement. See also **SYS** which is easier to use and more flexible.

VAL

Description
Extracts the numeric content of a string.

Syntax
VAL(<string>)
  e.g. VAL("1.01A") gives 1.01

Function
Starting from the left, VAL extracts first a sign, if present, then numerics and one decimal full stop, until a non-numeric or second full stop is reached. The number is then stripped of leading and trailing zeros to be held as a conventional numeric. e.g.

```
VAL ("-1.0.01 A") gives -1
VAL ("ABC") gives 0
VAL ("ABC123") gives 0
VAL ("-25.43") gives -25.43
```

VAL is the converse operation to **STR$**, and has rather more use. When using **INPUT** for numerics, an error occurs and the program terminates if a non-numeric is entered in a numeric field. It is therefore advisable to use a string variable and VAL e.g.

```
10 INPUT "NUMBER 1 TO 9";A$
20 IF VAL(A$)<1 OR VAL(A$)>9
GOTO 10
```

```
30 PRINT "OK"
```

See also the number checking routine in Section 3 and **INPUT**.

VERIFY

Description
Checks a **SAVE**d program.

Syntax
VERIFY ["<program name>"][,<device>]
e.g. VERIFY "PROGRAM"

Function
The program name is read from the device (defaults to cassette if not specified) and checks against the contents of memory. A VERIFY ERROR message is produced if the title and data contents do not exactly match. **VERIFY** can also be used within a program e.g.

```
5010 SAVE "@0:PROGRAM",8
5020 VERIFY "PROGRAM",8
5030 PRINT "END":END
```

Note that this cannot be used on cassette without a **WAIT** at 5015 or

```
5015 PRINT "REWIND CASSETTE,
PRESS PLAY THEN RETURN"
5017 INPUT A$
```

otherwise the program goes straight into **VERIFY** as the tape is still running.

WAIT

Description
The program waits for an external event.

Syntax
WAIT <location>,<mask1>,[<mask2>]
e.g. WAIT 1,48 waits for cassette to be stopped on CBM 64.
(48 is the bit pattern 00110000 set in location 1 when the tape starts, and cleared when it stops)

Function
WAIT halts the BASIC program until an external event such as the pressing of a key on the cassette recorder or the expiry of time occurs. It does this by watching the location specified for a defined pattern. Normally the location will be one of the I–O registers or a related position. This location need not be a number, an expression will be evaluated to an integer even if it is not, in fact, an integer.

To define the pattern being **WAIT**ed for, the contents of the location are **AND**ed with mask1, complemented and **AND**ed with mask2, if present. In other words, if any location bits are 1 in positions corresponding to 1s in mask1 or 0 in positions corresponding to 1s in mask2, the wait is over and the program proceeds.

SECTION 3 USEFUL ROUTINES

Introduction

The examples set out in this section of the book are intended to illustrate the way programs can be built up using the BASIC described in detail in Section 2. The BASIC syntax (i.e. language construction) is very flexible, and commands can be combined or nested in countless different ways and to a complex level before the interpreter can no longer cope. In fact the usual limitation is the ability of the human brain to easily understand complex constructs that limits the complexity of code, rather than BASIC. Complex solutions are therefore better implemented by carefully constructed combinations of simple easy to understand code, than by convoluted code nested deep in **FOR** loops and **GOSUB**s with a sprinkling of **GOTO**s.

To get started on the computer is extremely easy, but many people don't realise this. After a little while playing with the machine, reading from the manual, most children can produce a simple program like PROTEST below, which apart from line 5 is exactly as it was written by my 9 year old daughter.

```
5 REM PROTEST
10 PRINT"BOOOOOOO HOOOOOOOO"
20 PRINT"I CAN'T PLAY FOOTBALL"
30 PRINT"MUM WON'T LET ME."
40 PRINT"HELP ME"
50 PRINT"
60 PRINT"HELP ME"
70 GOTO 10

READY.
```

Another slightly longer program which requires little knowledge of BASIC, but an understanding of the way sound and colour is generated (in your VIC 20 manual) is as follows.

```
10 REM MUSIC
20 SC=53281:PRINT "J":POKE SC,1
30 CL=55296:S=54272:FOR N=S TO S+24:POKE N,0:NEXT
40 POKE SD+5,9:POKE SD+9,0:POKE SD+24,15
50 READ DA,TA,LN
60 REM RANDOM COLOURED SQUARES ON THE SCREEN
70 RD=INT(RND(1)*1000)
80 POKE RD+1024,32+128
90 CO=INT(RND(1)*17):IF CO=1 THEN 90
100 IF DA=999 THEN RESTORE:GOTO 50
110 POKE RD+CL,CO
120 :
130 REM PLAY NOTE
140 POKE SD+1,DA:POKE SD,TA:POKE SD+4,33
150 FOR N=1 TO LN*2:NEXT
160 POKE SD+4,32
170 GOTO 50
180 REM ************DATA******************       **
      **********DATA******************
190 DATA 14,107,150,19,63,300
200 DATA 21,154,150,22,227,300
210 DATA 28,214,150,25,177,300
220 DATA 19,63,150,19,63,300
230 DATA 38,126,150,38,126,300
240 DATA 38,126,150,34,75,300
250 DATA 28,214,150,28,214,600
260 DATA 38,126,75,38,126,75
270 DATA 38,126,300,21,154,150
280 DATA 22,227,300,28,214,150
290 DATA 25,177,150,19,63,150
300 DATA 19,63,150
310 DATA 19,63,300
320 DATA 19,63,150
330 DATA 19,63,300,19,63,150
340 DATA 18,42,300,18,42,150
350 DATA 19,63,300
360 DATA 999,999,999

READY.
```

The first few lines of this program generate random colours in random positions on the screen, and the last few lines generate the music from the data read in line 190. The data is used exclusively to generate the music.

The examples that follow are in some cases quite complex and although all have been tested or used for various applications, the sharp programmers amongst you will very probably feel there are better ways of carrying out some of these functions. If so then this book has served its purpose and of course I would be pleased to hear of any improvements.

SORT

The two programs below both work on the principle of a bubble sort. Starting with the first two items in the list of numbers or words, the program compares them and swaps them if the order is wrong. It then goes on to the second and third items, third and fourth items and so on to the bottom of the list. Having passed the list once it then repeats the process until the items are all in the right order, i.e. no further swaps are carried out during a pass of the list. Thus an item at the bottom of the list will rise one postion at a time until it arrives under the item next to which it belongs.

```
10 S1=36874:POKE 36878,15:POKE 36879,30
20 GOSUB 300
30 PRINT"▒███ENTER   EACH   NUMBER,AND   WHEN   YO
    U  HAVEFINISHED,     PRESS   'RETURN'."
40 PRINT"██ UP TO ONE HUNDRED    NUMBERS MAY BE EN
    TERED"
50 PRINT"█████      ▒▒HIT ANY KEY▒":GOSUB 290
60 PRINT"▒":AM=100:DIM NO(AM)
70 FOR N=1TOAM
80 PRINT"▒ENTER NUMBER▒"N"▒:▒"
90 INPUT NO$
100 IF NO$="" THEN 150
110 NO(N)=VAL(NO$):NO$=""
120 X=X+1
130 FOR L=1TO25:POKE S1+1,240:NEXT:POKE S1+1,0
140 NEXT N
150 REM***************       ** SORTING   **
     ***************
160 GOSUB 300:PRINT"▒███ SORTING.."
170 AM=X:X=0:N=1
180 PRINT"█      PLEASE WAIT..."
190 IF NO(N)>NO(N+1) THEN NO=NO(N):NO(N)=NO(N+1):N
    O(N+1)=NO:X=0
200 X=X+1:N=N+1:IF N>=AM THEN N=1
210 IF X<>AM THEN 190
220 REM***************       ** PRINTING  **
     ***************
230 GOSUB 300:PRINT"██"
240 FOR N=1 TO AM
250 P=P+1:IF P/18=INT(P/18)THEN GOSUB 280:PRINT"██
    "
260 IF NO(N)<>0 THEN PRINT "■"NO(N)
270 NEXT N:PRINT "▒END OF LIST":END
280 PRINT"▒    ▒HIT ANY KEY"
290 GET KY$:IF KY$="" THEN 290
300 PRINT"▒█*** ▒NUMBER SORT ▒****█"
310 RETURN

READY.
```

```
10 REM NO SORT
20 REM SORTS NUMBERS INTO ASCENDING ORDER
30 VL=54296:BD=53280:SC=53281:SD=54272:REM COLOUR
    & SOUND
40 POKE VL,15:REM VOLUME
50 POKE BD,6:POKE SC2,1:REM SCREEN COLOURS
60 POKE SD+6,248:REM SOUND
70 GOSUB 490
80 PRINT"▒███         ENTER EACH NUMBER, AND"
90 PRINT TAB(8)"WHEN YOU HAVE FINISHED"
100 PRINT TAB(11)"PRESS 'RETURN'."
110 PRINT TAB(10)"██UP TO ONE THOUSAND
             NUMBERS MAY BE ENTERED"
120 PRINT"█████             ▒▒HIT ANY KEY▒":GOSUB 4
    80
130 AM=1000:DIM NO(AM)
140 FOR N=1TOAM
150 PRINT"▒     ENTER NUMBER▒"N"▒:▒"
160 INPUT "     ";NO$
170 IF NO$="" THEN 290
180 NO(N)=VAL(NO$):NO$=""
190 X=X+1
200 POKE SD+5,190
210 POKE SD+6,248
```

```
220 POKE SD+1,20+INT(RND(1)*20):POKE SD,37
230 POKE SD+4,17
240 FOR L=1 TO 100:NEXT L
250 POKE SD+4,0
260 POKE SD+5,0:POKE SD+6,0
270 NEXT N
280 :
290 REM*********** SORTING ***********
300 :
310 TI$="000000"
320 GOSUB 490:PRINT"▓▓▓▓▓▓ SORTING.."
330 AM=X:X=0:N=1
340 PRINT"▓      PLEASE WAIT..."
350 IF NO(N)>NO(N+1) THEN NO=NO(N):NO(N)=NO(N+1):N
    O(N+1)=NO:X=0
360 X=X+1:N=N+1:IF N>=AM THEN N=1
370 IF X<>AM THEN 350
380 T$=TI$
390 :
400 REM******* PRINTING NUMBERS *******
410 :
420 GOSUB 490:PRINT"▓"
430 FOR N=1 TO AM
440 P=P+1:IF P/18=INT(P/18)THEN GOSUB 510
450 IF NO(N)<>0 THEN PRINT TAB(TB);"▓"NO(N)
460 NEXT N:PRINT TAB(TB);"▓▓▓END OF LIST▓▓":PRINT"
    ":END
470 PRINT"▓    ▓HIT ANY KEY"
480 GET KY$:IF KY$="" THEN 480
490 PRINT"▓▓          ▓**** ▓NUMBER SORT ▓*****▓"
500 RETURN
510 A=A+1:TB=A*12:IF A=3THEN A=-1:GOSUB 470:GOTO 5
    10
520 PRINT"▓▓▓▓▓":RETURN

READY.
```

```
5 REM***************        ** WORD SORT **       *
    ***************
10 S1=36874:POKE 36878,15:POKE 36879,30
20 GOSUB 300
30 PRINT"▓▓▓▓ENTER  EACH  WORD  ,AND  WHEN  YO
    U  HAVEFINISHED,   PRESS  'RETURN'.
40 PRINT"▓▓ UP TO ONE HUNDRED   WORDS  MAY BE  EN
    TERED"
50 PRINT"▓▓▓▓▓      ▓▓HIT ANY KEY▓":GOSUB 290
60 PRINT"▓":AM=100:DIM NO$(AM)
70 FOR N=1TOAM
80 PRINT"▓ENTER WORD▓"N"▓:▓"
90 INPUT NO$
100 IF NO$="" THEN 150
110 NO$(N)=NO$:NO$=""
120 X=X+1
130 GOSUB 320
140 NEXT N
150 REM***************        ** SORTING   **
    ***************
160 GOSUB 300:PRINT"▓▓▓ SORTING.."
170 AM=X:X=0:N=1
180 PRINT"▓      PLEASE WAIT..."
190 IF NO$(N)>NO$(N+1) THEN NO$=NO$(N):NO$(N)=NO$(
    N+1):NO$(N+1)=NO$:X=0
200 X=X+1:N=N+1:IF N>=AM THEN N=1
210 IF X<>AM THEN 190
220 REM***************        ** PRINTING  **
    ***************
230 GOSUB 300:PRINT"▓▓"
240 FOR N=1 TO AM
250 P=P+1:IF P/18=INT(P/18)THEN GOSUB 280:PRINT"▓▓
    "
260 IF NO$(N)<>"" THEN PRINT "▓"NO$(N):GOSUB 320
270 NEXT N:PRINT "▓▓▓▓":END
280 PRINT"▓    ▓HIT ANY KEY"
290 GET KY$:IF KY$="" THEN 290
300 PRINT"▓▓***** ▓WORD SORT ▓*****▓"
310 RETURN
320 R=INT(RND(1)*10):FOR L=1TO25:POKE S1+1,235+R:N
    EXT:POKE S1+1,0:RETURN

READY.
```

```
10 VL=54296:BD=53280:SC=53281:SD=54272:REM VOLUME
    AND COLOURS
20 POKE VL,15
30 POKE BD,6:POKE SC,1
40 POKE SD+6,248
50 GOSUB 470
60 PRINT"▓▓▓▓        ENTER EACH WORD ,  AND"
70 PRINT TAB(8)"WHEN YOU HAVE FINISHED"
80 PRINT TAB(11)"PRESS 'RETURN'."
90 PRINT TAB(10)"▓▓UP TO ONE THOUSAND
            WORDS MAY BE ENTERED"
100 PRINT"▓▓▓▓▓▓            ▓▓HIT ANY KEY▓":GOSUB 4
    60
110 AM=1000:DIM NO$(AM)
120 FOR N=1TOAM
130 PRINT"▓     ENTER WORD▓"N"▓:▓"
140 INPUT "     ";NO$(N)
150 IF NO$(N)="" THEN 260
160 X=X+1
```

```
170 POKE SD+5,190
180 POKE SD+6,248
190 POKE SD+1,20+INT(RND(1)*20):POKE SD,37
200 POKE SD+4,17
210 FOR L=1 TO 100:NEXT L
220 POKE SD,0
230 POKE SD+1,0:POKE SD+4,0
240 NEXT N
250 :
260 REM**********  SORTING  **********
270 REM USES BUBBLE SORT - COMPARES PAIRS
280 :
290 TI$="000000"
300 GOSUB 470:PRINT"██████ SORTING.."
310 AM=X:X=0:N=1
320 PRINT"█      PLEASE WAIT..."
330 IF NO$(N)>NO$(N+1) THEN NO$=NO$(N):NO$(N)=NO$(
    N+1):NO$(N+1)=NO$:X=0
340 X=X+1:N=N+1:IF N>=AM THEN N=1
350 IF X<>AM THEN 330
360 T$=TI$
370 :
380 REM****** PRINTING WORDS ******
390 :
400 GOSUB 470:PRINT"█"
410 FOR N=1 TO AM
420 P=P+1:IF P/18=INT(P/18)THEN GOSUB 490
430 IF NO$(N)<>"" THEN PRINT TAB(TB);"█"NO$(N)
440 NEXT N:PRINT TAB(TB);"██END OF LIST██":PRINT"
    ":END
450 PRINT"█     █HIT ANY KEY"
460 GET KY$:IF KY$="" THEN 460
470 PRINT"██          █***** █WORD SORT █*****█"
480 RETURN
490 A=A+1:TB=A*20:IF A=2THEN A=-1:GOSUB 450:GOTO 4
    90
500 PRINT"██████":RETURN

READY.
```

The bubble sort is easy to understand but very inefficient under most circumstances. Many better sorts exist; most are difficult to understand but usually fairly easy to use by incorporating them as subroutines in your program. One such subroutine is shown below.

```
1 REM ** J IS NO OF WORDS TO GO
3 REM ** S IS NO OF WORDS DONE, OR THE
4 REM ** POSITION IN THE ARRAY.
5 REM ** A$() IS THE ARRAY
6 REM ** THIS PROG LOOKS AT EACH
7 REM ** INDIVIDUAL WORD, AND SORTS IT
8 REM ** OUT ON ITS OWN, AND THEN GOES
9 REM ** ON TO THE NEXT WORD.
10 FOR N=1 TO 100
20 INPUT A$(N)
30 IF A$(N)="*" THEN 100
40 NEXT N
100 REM QUICKSORT ROUTINE
110 DIM SL(100),SR(100)
120 S=1:SL(1)=1:SR(1)=N
130 L=SL(S):R=SR(S):S=S-1
140 I=L:J=R:X$=A$(INT((L+R)/2))
150 IF A$(I)<X$ THEN I=I+1:GOTO 150
160 IF X$<A$(J) THEN J=J-1:GOTO 160
170 IF I>J THEN 1190
180 W$=A$(I):A$(I)=A$(J):A$(J)=W$:I=I+1:J=J-1
190 IF I<=J THEN 150
200 IF I>=R THEN 220
210 S=S+1:SL(S)=I:SR(S)=R
220 R=J:IF L<R THEN 140
230 IF S<>0 THEN 130
240 FOR N=1 TO 100:PRINT A$(N):NEXT

READY.
```

NUMERIC CHECK

There are a number of numeric checks that can be carried out to see if a string that has been input is a numeric. The simplest is the **VAL** function, but this does not cater for the case of 0 or where some extraneous characters have been added. The cases most commonly considered are integer, money and decimal. However there is no reason why binary or hexadecimal or octal cannot be checked for by writing special validation routines using all or part of the general routine for a decimal number given below.

```
10 REM NUMERIC CHECK ROUTINE. CHECKS ADECIMAL ENTR
    Y OF UP TO NINE NUMERALS
```

```
20 REM IF VALID NUMBER IN 'NO$' IS RETURNED AS 'NO
   '
30 INPUT"TEST NUMBER";NO$
40 NO=VAL(NO$):CK$=STR$(NO)
50 REM STRIP OFF LEADING SPACES AND ZEROS AND TRAI
   LING SPACES
60 IF LEFT$(NO$,1)=" "THEN NO$=RIGHT$(NO$,LEN(NO$)
   -1):GOTO 50
65 IF LEFT$(NO$,1)="0"AND NO$<>"0" THEN NO$=RIGHT$
   (NO$,LEN(NO$)-1):GOTO 50
70 IF LEFT$(CK$,1)=" "THEN CK$=RIGHT$(CK$,LEN(CK$)
   -1)
80 IF RIGHT$(NO$,1)=" "THEN NO$=LEFT$(NO$,LEN(NO$)
   -1):GOTO 70
90 IF NO$=CK$ THEN PRINT "OK"
100 PRINT NO$;"  ";CK$
110 GOTO 30

READY.
```

The string manipulation in the above routine may also be of some interest. It provides a method of reducing a string until unwanted filler characters have been entirely removed.

RANDOM GROUPS

The dice rolling and holding program below illustrates the use of random numbers in a selection from 1 to 6, then incorporated in pictures of dice. The sound effects are also randomly generated. Note the use of the screen as an input device.

```
10 POKE 53280,3:POKE 53281,1:GOSUB 1000
15 DIM HD(25)
20 OPEN 1,0
30 GOSUB 1010
40 PRINT"█ DO YOU WANT INSTRUCTIONS?"
45 PRINT TAB(10);
50 INPUT#1,YN$
60 IF LEFT$(YN$,1)<>"Y" THEN150
70 GOSUB 1000:PRINT "███        █PRESS █R█ TO █ROLL
   THE DICE"
80 PRINT "██        PRESS A █NUMBER█ TO █CHANGE█"
90 PRINT"        THE NUMBER OF █DICE█ ROLLED"
100 PRINT:PRINT:PRINT"      PRESS █H█ AND THE █NO O
   F THE DIE"
110 PRINT"              TO █HOLD█ DICE"
120 PRINT "     TO SEPERATE DIE WANTING TO BE "
125 PRINT "    █HELD█, TYPE A COMMA, THEN RETURN"
130 PRINT"██          █HIT█ANY█KEY█TO█START"
140 GET KY$:IF KY$="" THEN 140
150 GOSUB 1000:PRINT
155 REM************ KEYS **************        ***
   *****************************
160 GET KY$:IF KY$="" THEN 160
165 IF ASC(KY$)=13 THEN CH=2
170 IF KY$="H" THEN GOSUB 500
175 IF KY$>="0" AND KY$<="9" AND CH=2 THEN GOSUB 9
   90
180 IF KY$=>"0" AND KY$=<"9" THEN GOSUB 990:IF DC>
   24 THEN CH=2:GOTO 155
190 IF KY$<>"R"THEN 160
200 REM************ PRINTING ***********       ***
   *****************************
205 CH=2
210 FOR N=1 TO DC:POKE LF,INT(RND(1)*200)+1:POKE H
   F,INT(RND(1)*200)+1
215 PRINT"██"N"███";:FOR NN=1 TO LEN(STR$(N)):PRIN
   T"█";:NEXT NN
220 PRINT"█ ╭───╮██████";
230 PRINT"│███│██████";
240 PRINT"│███│██████";
250 PRINT"│███│██████";
260 PRINT"╰───╯TTT██████";
265 FOR L=1 TO 24:IF N=HD(L) THEN PRINT"██████";:G
   OTO 290
266 NEXT L
267 PRINT"██   ████   ████   TT████";
270 RD=INT(RND(1)*6)+1
280 ON RD GOSUB 400,410,420,430,440,450
290 IF N/8=INT(N/8)THEN PRINT:PRINT:PRINT
300 POKE HF,0:POKE LF,0
390 NEXT N:PRINT"████";:GOTO 155:REM START AGAIN
400 PRINT"██████TTT";:RETURN
410 PRINT"██████TTT█";:RETURN
420 PRINT"██████TTT█";:RETURN
430 PRINT"███████████TTT███";:RETURN
440 PRINT"███████████TTT██";:RETURN
450 PRINT"██████████████TTT█";:RETURN
500 REM********************************
510 REM***      HOLD THE DICE        ***
520 REM********************************
524 FOR H=1 TO 24:HD(H)=0:NEXT H
525 H=0
530 H=H+1
```

```
540 GET KY$:IF KY$="" THEN 540
550 IF KY$="." THEN HD(H)=VAL(HD$):HD$="":GOTO 530
560 IF ASC(KY$)=13 THEN HD(H)=VAL(HD$):HD$="":PRIN
     T "█   ██":RETURN
570 IF KY$<"0" OR KY$>"9" THEN 540
580 HD$=HD$+KY$
590 PRINT "█"HD$:GOTO 530
600 :
980 DC$="":CH=0:GOSUB 1000:PRINT:FOR N=1 TO 24:HD(
     N)=0:NEXT:RETURN
990 DC$=DC$+KY$:DC=VAL(DC$):RETURN
1000 PRINT "███████████**** ROLL█-A█-DIE █
     ****":RETURN
1010 REM*********** SET VOICE 1 ********         **
     ******************************
1015 SD=54272
1020 FOR N=SD TO SD+24:POKE N,0:NEXT
1030 POKE SD+24,15:REM ** VOLUME
1040 POKE SD+5,190:REM ** ATTACK/DECAY
1050 POKE SD+6,248:REM ** SUS/RELEASE
1060 LF = SD
1070 HF = SD+1
1090 POKE SD+4,17 :REM ** WAVEFORM
1110 RETURN

READY.
```

BASE CONVERTER

The base converter program below provides a useful utility for hexadecimal (hex) to decimal and the reverse conversion. Once in hex it is easy to produce binary, as each hex character maps directly on to 4 binary bits. See **AND**, and **OR** for the methods that can be used for bit manipulation.

```
10 SC=53281:POKE SC,1:REM SET SCREEN TO WHITE
20 REM****************        ** CONVERTER **
    ****************
30 GOSUB 610:PRINT"█████     HEX-DEC OR DEC-HEX ?"

40 PRINT"█        █H █FOR █HEX-DEC"
50 PRINT"        █D █FOR █DEC-HEX"
60 PRINT"        █E █FOR █ENDING█"
70 PRINT"██        █S █FOR █STOPPING WHILE ENTERING
                         NUMBERS"
80 GET KY$:IF KY$<>"H" AND KY$<>"D"AND KY$<>"E"THE
     N 80
90 PRINT"█"
100 IF KY$="E" THEN END
110 IF KY$="H" THEN 370
120 REM****************       ** VARIABLES  **
     ****************
130 REM DE$ IS DECIMAL NUMBER ENTERED
140 REM DE IS ITS NUMERIC EQUIVALENT
150 REM DS$ = STRING OF NOS FROM DE WITHOUT LEADIN
     G SPACE - FOR NO. VALIDATION
160 REM D AND E ARE VARIABLES FOR NUMBER MANIPULAT
     ION
170 REM RE$() IS HEX REMAINDER AFTER N+1TH DIVISIO
     N
180 REM****************       ** DECIMAL-HEX**
     ****************
190 GOSUB 610:PRINT"██  DECIMAL        HEXADECIMAL
     "
200 INPUT DE$:DE=VAL(DE$):D=DE:N=0:IF DE$="S" THEN
     20
210 DS$=RIGHT$(STR$(DE),LEN(STR$(DE))-1):REM REMOV
     ES SPACE BEFORE NO.
220 IF DS$<>DE$ THEN PRINT"NOT DECIMAL":GOTO 200:R
     EM DECIMAL CHECK
230 E=INT(D/16)
240 :
250 RE$(N)=STR$(D-E*16):D=E
260 IF VAL(RE$(N))>9 THEN RE$(N)=CHR$(VAL(RE$(N))+
     55)
270 :
280 IF D<10 THEN 330
290 :
300 N=N+1:GOTO 230
310 REM** BUILD UP HEX NO. FROM ARRAY.
320 REM HE$=HEX NO.
330 HE$="":IF D>0 THEN HE$=HE$+STR$(D)
340 FOR L=N TO 0 STEP-1:HE$=HE$+RIGHT$(RE$(L),1):N
     EXT
350 PRINT "█"TAB(18);HE$
360 GOTO 200
370 REM****************       **HEXADEC-DEC**
     ****************
380 GOSUB 610:PRINT"██ HEXADECIMAL       DECIMAL█"

390 HE$="":INPUT HE$:H=LEN(HE$)+1:IF HE$="S" THEN
     20
400 IF H-1>10 THEN PRINT" SHORTER NUMBER PLEASE!":
     GOTO 390
410 :
420 REM CREATE AND CHECK ARRAY
```

```
430 FOR N=H-1 TO 1 STEP-1:RE$(H-N)=MID$(HE$,N,1):H
     N=ASC(RE$(H-N))
440 IF HN>70 THEN PRINT "NOT HEX!":GOTO 390
450 IF HN<48 THEN PRINT "NOT HEX!":GOTO 390
460 IF HN>57 AND HN<65 THEN PRINT "NOT HEX!":GOTO
     390
470 IF HN>64 THEN RE(H-N)=ASC(RE$(H-N))-55:NEXT N:
     GOTO 510
480 RE(H-N)=VAL(RE$(H-N)):NEXT N
490 :
500 REM BUILD DECIMAL NUMBER ITEM BY ITEM (EACH IT
     EM IS BETWEEN 0 AND 15)
510 FOR L=1 TO H-1:D(L)=RE(L)*(16↑(L-1)):NEXT
520 :
530 FOR L=1 TO H-1:DE=DE+D(L):NEXT:REM ADD UP THE
     ITEMS
540 REM*** PRINTING***
550 PRINT "■"TAB(18);DE:DE=0
560 GOTO 390
570 :
580 :
590 :
600 :
610 PRINT"■■          ■***** ■C■O■N■V■E■R■T■E■R ■**
     ***":RETURN

READY.
```

```
10 rem***************       ** converter **
     ***************
20 gosub 480:print"■■■■■ hex-dec or dec-hex ?"
30 print"■  ■h ■for ■hex-dec"
40 print"  ■d ■for ■dec-hex"
50 print"  ■e ■for ■ending■"
55 print"■■■  ■s ■for ■stopping whileentering numb
     ers"
60 get ky$:if ky$<>"h" and ky$<>"d"and ky$<>"e"the
     n 60
70 print"■"
75 if ky$="e" then end
80 if ky$="h" then 280
90 rem****************      ** decimal-hex**
     ****************
100 gosub 480:print"■■  decimal  hexadecimal■"
110 input de$:de=val(de$):d=de:n=0:if de$="s" then
      10
120 :
130 e=int(d/16)
140 :
150 re$(n)=str$(d-e*16):d=e
160 if val(re$(n))>9 then re$(n)=chr$(val(re$(n))+
     55)
170 :
180 if d<10 then 220
190 :
200 n=n+1:goto 130
210 rem** working **
220 he$="":if d>0 then he$=he$+str$(d)
230 for l=n to 0 step-1:he$=he$+right$(re$(l),1):n
     ext
250 print "■"tab(14);he$
260 goto 110
280 rem***************        **hexadec-dec**
     ***************
290 gosub 480:print"■■ hexadecimal   decimal"
300 input he$:h=len(he$)+1:if he$="s" then 10
310 :
320 for n=h-1 to 1 step-1:re$(h-n)=mid$(he$,n,1)
330 if asc(re$(h-n))>64 then re(h-n)=asc(re$(h-n))
     -55:next n:goto 360
340 re(h-n)=val(re$(h-n)):next n
350 :
360 for l=1 to h-1:d(l)=re(l)*(16↑(l-1)):next
370 :
380 for l=1 to h-1:de=de+d(l):next
390 rem*** printing***
400 print "■"tab(14);de:de=0
410 goto 300
440 :
450 :
460 :
470 :
480 print"■****** ■c■o■n■v■e■r■t■e■r ■*****":retur
     n
```

In this program the colon has been used to make the code more readable by separating blocks of code. In other machine BASICs the apostrophe (') would be used as shorthand for **REM**, but this is not available in VIC/CBM 64 BASIC, so the dummy statement represented by colon can be used in a line on its own.

BUSINESS FORMS

A requirement in business is to be able to enter information onto a form-style layout in order to set up records on disk or tape. This makes the entry of information a much more routine affair that can be left to non-computer trained staff who are guided through the entries by the form layout.

The first program listed is a screen form creation program that allows a programmer or non-programmer to lay out a screen and then store it on tape. This saves a lot of coding in screen handling programs which simply pick up and use the appropriate form from tape (or disk). In this program, the screen is set up by moving the cursor around and setting up strings or entry fields wherever required. The program is then run and picks up and compresses the data on the screen (first 2Ø lines) before writing it to tape. Brackets () are used to delineate the areas where entries are to be made. The program stores only the start position and contents of strings (defined as containing no more than one contiguous space) and the start position and length of the spaces to be reserved for entries ('permitted fields'). The rest of the screen (empty space and the last two lines) are ignored. Note the use of function keys to allow rapid entry.

```
5 REM SCRGEN - GENERATES A SCREEN FORMAT ON A TAPE
     ALLOWING TEXT ENTRY AND...
6 REM BRACKETS TO INDICATE WHERE FIELDS WILL BE EN
    TERED BY A PROGRAM USING...
7 THE STORED SCREEN FORMAT
8 REM RUN BY SETTING UP THE REQUIRED SCREEN AND TH
    EN PRESSING RUN
9 REM SA$=STRT ADDRESS OF STRING
10 OPEN1,1,1,"SCREEN"
20 SC=1023:PK=32
30 REM*** ONLY FIRST 20 LINES OF SCREEN ARE CONSID
    ERED ***
40 FOROF=1TO800:REM WORK THROUGH 20 LINES OF SCREE
    N (800 POSITIONS)
50 PR=PK:PK=PEEK(SC+OF):CR$=CHR$(PK)
52 IFPK<32THENCR$=CHR$(PK+64)
54 IFPK>63THENCR$=CHR$(PK+32)
70 IFPK=32ANDPR=32THEN105
80 IFPK=32ANDPR<>32THENPRINT#1,SA:PRINT#1,SR$:GOTO
    105
90 IFPK<>32ANDPR=32THENSA=OF-1:SR$=CR$:GOTO105
100 SR$=SR$+CR$:GOTO105
105 NEXT
107 PRINT#1,999:PRINT#1,"END"
110 CLOSE1
120 PRINT "SCREEN STORED TO TAPE"
130 END
133 REM TEST ROUTINE TO CHECK THE SCREEN GENERATED
     ABOVE BY DISPLAYING IT
135 OPEN1,1,0,"SCREEN":J=1:OF=1023:CF=55295
137 PRINT"♥"
140 INPUT#1,A,A$:IFA=999THENPRINT"QQQQQQQQQQQQQQQQQ
    ":END
142 AC=ASC(MID$(A$,J,1)):PK=AC
144 IFAC>63THENPK=AC-64
146 IFAC>95THENPK=AC-32
150 POKEOF+A+J,PK
155 POKECF+A+J,1
160 IFJ=LEN(A$)THENJ=1:GOTO140
165 J=J+1:GOTO142

READY.
```

The next program will appear at first sight to have nothing whatever to do with the first program or with business forms, but it is an essential tool for building forms programs and has uses elsewhere. This second program is an extremely primitive word processor/line editor. When the program is running, a line can be typed and characters can be changed or deleted just as if in the screen editor excluding the vertical cursor movement,working on one line at a time. When <RETURN> is pressed, the line is typed out to the printer. As most of this program simulates the operating characteristics of the machine with no program in memory, there is probably a rather neat way of doing this in machine code using calls to BASIC ROM subroutines, but if we stick to BASIC, then this is the way it must be done.

```
10 REM TYPER 64
20 BD=53280:SC=53281
```

```
30 REM 'I' IS THE CURRENT POSITION IN THE LINE.
40 REM 'J' IS THE CURRENT POSITION IN THE PRINT LI
    NE WHEN PRINTING.
50 REM 'LC' IS THE LAST CHARACTER POSITION IN THE
    CURRENT LINE.
60 REM 'N' IS A POSITION IN THE CURRENT LINE USED
    DURING LINE MANIPULATION.
70 REM 'LI$()' IS AN ARRAY OF 80 SINGLE CHARS, EAC
    H REPRESENTING ONE LINE POSITION.
80 REM 'FL' IS THE CURSOR.
90 OPEN 4,4:I=0:POKE SC,1:POKE BD,3
100 PRINT "▓"CHR$(14)
110 DIM LI$(81)
120 FL$(1)="▒":FL$(2)=" "
130 REM
140 IF LC<I THEN LC=I
150 IF LC>I THEN FL$(2)=LI$(I+1):IF ASC(LI$(I+1))=
    34 THEN FL$(2)="▧'■"
160 IF LC=I THEN FL$(2)=" "
170 IF LC>79 THEN CH$=CHR$(13): GO TO 380
180 FORL=1TO2
190 FORK=1TO30
200 GET CH$:PRINTFL$(L)"▌":
210 IF CH$<>""THEN 260
220 NEXT K
230 NEXT L
240 GOTO 140
250 IF I=LC THEN PRINT" ▌"
260 PRINT FL$(2)"▌";:IF ASC(CH$)=20 THEN 450
270 IF ASC(CH$)=148 THEN 520:REM INSERT
280 IF ASC(CH$)=157 THEN 590:REM CURSOR <-
290 IF ASC(CH$)=29 THEN 630:REM CURSOR ->
300 IF ASC(CH$)=133 THEN CLOSE4:END:REM FN KEY 1 C
    AUSES EXIT
310 IF ASC(CH$)=13 OR ASC(CH$)=141 THEN 380:REM RE
    TURN KEY
320 IF ASC(CH$)<32 THEN 130:REM IGNORE INVALID CHA
    RACTERS
330 IF ASC(CH$)>127 ANDASC(CH$)<160 THEN 130:REM I
    GNORE MORE INVALID CHARACTERS
340 CA$=CH$
350 IF ASC(CH$)=34 THEN CA$="▧'■":REM SPECIAL HAND
    LING FOR "
360 I=I+1:PRINT CA$;:LI$(I)=CH$:GO TO 130
370 LI$(I)=CH$
380 REM***************        ** PRINTING  **
    ***************
390 PRINT:SN$=""
400 FOR J=1 TO LC+1
410 SN$=SN$+LI$(J):LI$(J)="":NEXT J:
420 PRINT#4,CHR$(17)SN$
430 REM PRINT#8,SN$
440 I=0:LC=0: GO TO 130
450 REM***************       **   DELETE  **
    ***************
460 I=I-1:IF I<0 THEN I=0:GO TO 130
470 LC=LC-1
480 PRINT CH$;
490 FOR N=I+1 TO LC+1:LI$(N)=LI$(N+1)
500 NEXT N
510 GO TO 130
520 REM***************       **   INSERT  **
    ***************
530 :LC=LC+1:LI$(LC)=" "
540 PRINT CHR$(148);
550 FOR N=LC TO I+1 STEP -1:LI$(N)=LI$(N-1)
560 NEXT N
570 LI$(I+1)=" "
580 GO TO 130
590 REM***************       ** CURSOR <- **
    ***************
600 I=I-1:IF I<0 THEN I=0:GO TO 130
610 PRINT "▌";
620 GO TO 130
630 REM***************       ** CURSOR -> **
    ***************
640 I=I+1:IF I>LC THEN LI$(I)=" "
650 PRINT FL$(2);:GO TO 130

READY.
```

Although the VIC is not really suitable as a business machine for most applications,this particular routine is useful on its own, so below is a VIC version of the same program.

```
5 REM************VIC 20 TYPER************
10 REM 'I' IS THE CURRENT POSITION IN THE LINE.
20 REM 'J' IS THE CURRENT POSITION IN THE PRINT LI
    NE WHEN PRINTING.
30 REM 'LC' IS THE LAST CHARACTER POSITION IN THE
    CURRENT LINE.
40 REM 'N' IS A POSITION IN THE CURRENT LINE USED
    DURING LINE MANIPULATION.
50 REM 'LI$()' IS AN ARRAY OF 80 SINGLE CHARS, EAC
    H REPRESENTING ONE LINE POSITION.
60 REM 'FL' IS THE CURSOR.
70 OPEN 4,4:I=0
80 PRINT "▓"CHR$(14)
90 DIM LI$(81)
100 FL$(1)="▒":FL$(2)=" "
110 REM
120 IF LC<I THEN LC=I
```

```
130 IF LC>I THEN FL$(2)=LI$(I+1):IF ASC(LI$(I+1))=
     34 THEN FL$(2)="ø′■"
140 IF LC=I THEN FL$(2)=" "
150 IF LC>79 THEN CH$=CHR$(13): GO TO 350
160 FORL=1TO2
170 FORK=1TO30
180 GET CH$:PRINTFL$(L)"▮";
190 IF CH$<>""THEN 240
200 NEXT K
210 NEXT L
220 GOTO 120
230 IF I=LC THEN PRINT" ▮"
240 PRINT FL$(2)"▮";:IF ASC(CH$)=20 THEN 430
250 IF ASC(CH$)=148 THEN 500
260 IF ASC(CH$)=157 THEN 590
270 IF ASC(CH$)=29 THEN 640
280 IF ASC(CH$)=133 THEN CLOSE4:END
290 IF ASC(CH$)=13 OR ASC(CH$)=141 THEN 350
300 IF ASC(CH$)<32 THEN 110
310 IF ASC(CH$)>127 ANDASC(CH$)<160 THEN 110
320 CA$=CH$
325 IF ASC(CH$)=34 THEN CA$="ø′■"
330 I=I+1:PRINT CA$;:LI$(I)=CH$:GO TO 110
340 LI$(I)=CH$
350 REM***************        ** PRINTING  **
     ***************
360 PRINT:SN$=""
370 FOR J=1 TO LC+1
380 SN$=SN$+LI$(J):LI$(J)="":NEXT J:
390 PRINT#4,CHR$(17)SN$
400 REM PRINT#8,SN$
420 I=0:LC=0: GO TO 110
430 REM***************        **   DELETE  **
     ***************
440 I=I-1:IF I<0 THEN I=0:GO TO 110
450 LC=LC-1
460 PRINT CH$;
470 FOR N=I+1 TO LC+1:LI$(N)=LI$(N+1)
480 NEXT N
490 GO TO 110
500 REM***************        **   INSERT  **
     ***************
510 PRINT " ";:LC=LC+1:LI$(LC)=" "
520 FOR N=I+1 TO LC
522 IF ASC(LI$(N))=34 THEN PRINT "ø′■";
524 IF ASC(LI$(N))<>34 THEN PRINT LI$(N);
530 NEXT N
540 FOR N=I TO LC:PRINT "▮";:NEXT N
550 FOR N=LC TO I+1 STEP -1:LI$(N)=LI$(N-1)
560 NEXT N
570 LI$(I+1)=" "
580 GO TO 110
590 REM***************        ** CURSOR <- **
     ***************
610 I=I-1:IF I<0 THEN I=0:GO TO 110
620 PRINT "▮";
630 GO TO 110
640 REM***************        ** CURSOR -> **
     ***************
650 I=I+1:IF I>LC THEN LI$(I)=" "
670 PRINT FL$(2);:GO TO 110

READY.
```

Now defining all the fields in TYPER64 variably instead of as a standard 80 characters long, and if the output is written to an array rather than the printer, then the combination of this program with a routine to read the screen format created earlier, will provide a business entry form:

```
5 REM SCREENUSE
10 DIM LI$(81),EN(20),EX(20),ST$(20)
20 GOSUB4000
30 GOSUB5100:IFST$(1)="*"THEN50
40 GOSUB100:GOSUB6000:GOTO30
50 PRINT"DONE":END
100 REM FUNCTION SUBROUTINE
110 RETURN
4000 REM BUILD SCREEN SUBROUTINE
4010 INPUT "SCREEN NAME";SC$
4020 R=1:T=1:OF=1023:CF=55295
4030 OPEN1,1,0,SC$:PRINT"♡"
4040 INPUT#1,A,A$:IFA=999THENEN(T)=A:RETURN
4042 AC=ASC(MID$(A$,R,1)):PK=AC
4044 IFAC>63THENPK=AC-64
4046 IFAC>95THENPK=AC-32
4050 POKEOF+A+R,PK
4060 POKECF+A+R,1
4070 IFLEN(A$)=1ANDA$="("THENEN(T)=A+1
4080 IFLEN(A$)=1ANDA$=")"THENEX(T)=A-EN(T):T=T+1
4090 IFR=LEN(A$)THENR=1:GOTO4040
4100 R=R+1:GOTO4042
5100 REM ACCEPT INPUT SUBROUTINE
5110 REM 'P' IS THE START POSITION OF THE CURRENT
     LINE.
5120 REM 'I' IS THE CURRENT POSITION IN THE LINE.
5130 REM 'J' IS THE CURRENT POSITION IN THE PRINT
     LINE WHEN PRINTING.
```

```
5140 REM 'LC' IS THE LAST CHARACTER POSITION IN TH
     E CURRENT LINE.
5150 REM 'N' IS A POSITION IN THE CURRENT LINE USE
     D DURING LINE MANIPULATION.
5160 REM 'LI$()' IS AN ARRAY OF 80 SINGLE CHARS, E
     ACH REPRESENTING ONE LINE PSN
5170 REM 'FL' IS THE CURSOR.
5180 I=0:P=1
5190 PRINT"▚▚";
5200 FORQ=1TOEN(P):PRINT"▮";:NEXT
5210 FL$(1)="▒":FL$(2)=" "
5220 REM
5230 IFLC<ITHENLC=I
5240 IFLC>ITHENFL$(2)=LI$(I+1):IF ASC(LI$(I+1))=34
     THENFL$(2)="▚'▀"
5250 IFLC=ITHENFL$(2)=" "
5260 IFLC>=EX(P)THENCH$=CHR$(13):GOTO5470
5270 FORL=1TO2
5280 FORK=1TO30
5290 GETCH$:PRINTFL$(L)"▮";
5300 IFCH$<>""THEN5350
5310 NEXT
5320 NEXT
5330 GOTO5230
5340 IFI=LCTHENPRINT" ▮"
5350 PRINTFL$(2)"▮";:IFASC(CH$)=20THEN5560
5360 IFASC(CH$)=148THEN5630
5370 IFASC(CH$)=157THEN5740
5380 IFASC(CH$)=29THEN5780
5390 IFASC(CH$)=133THENRETURN
5395 IFASC(CH$)=134THENST$(1)="*":RETURN
5400 IFASC(CH$)=13ORASC(CH$)=141THEN5470
5410 IFASC(CH$)<32THEN5220
5420 IFASC(CH$)>127ANDASC(CH$)<160THEN5220
5430 CA$=CH$
5440 IFASC(CH$)=34THENCA$="▚'▀"
5450 I=I+1:PRINTCA$;:LI$(I)=CH$:GOTO5220
5460 LI$(I)=CH$
5470 REM STOREING
5480 SN$=""
5500 IFEN(P+1)<>999THENFORQ=EN(P)+ITOEN(P+1)-1:PRI
     NT"▮";:NEXT
5510 FORJ=1TOLC+1
5520 SN$=SN$+LI$(J):LI$(J)="":NEXT
5530 ST$(P)=SN$:P=P+1
5535 I=0:LC=0
5540 IFEN(P)=999THENRETURN
5550 GOTO5220
5560 REM  DELETE
5570 I=I-1:IFI<0THENI=0:GOTO5220
5580 LC=LC-1
5590 PRINTCH$;
5592 FORN=2TOEX(P)-I:PRINT"▮";:NEXT:PRINT" )";
5594 FORN=0TOEX(P)-I:PRINT"▮";:NEXT
5600 FORN=I+1TOLC+1:LI$(N)=LI$(N+1)
5610 NEXT
5620 GOTO5220
5630 REM INSERT
5640 PRINT " ";:LC=LC+1:LI$(LC)=" "
5650 FORN=I+1TOLC
5660 IFASC(LI$(N))=34THENPRINT"▚'▀";
5670 IFASC(LI$(N))<>34THENPRINTLI$(N);
5680 NEXT
5690 FORN=ITOLC:PRINT"▮";:NEXT
5700 FORN=LCTOI+1STEP-1:LI$(N)=LI$(N-1)
5710 NEXT
5720 LI$(I+1)=" "
5730 GOTO5220
5740 REM CURSOR <-
5750 I=I-1:IFI<0THENI=0:GOTO5220
5760 PRINT"▮";
5770 GOTO5220
5780 REM CURSOR ->
5790 I=I+1:IFI>LCTHENLI$(I)=" "
5800 PRINTFL$(2);:GOTO5220
6000 REM CLEAR ENTRIES SUBROUTINE
6010 PRINT"▚";:FORR=1TOEN(1):PRINT"▮";:NEXT
6020 FORU=1TOT-1
6030 FORR=1TOEX(U):PRINT" ";:NEXT
6040 IFEN(U+1)<>999THEN:FORR=1+EN(U)+EX(U)TOEN(U+1
     ):PRINT"▮";:NEXT
6050 NEXT:RETURN

READY.
```

The next stage is to include a read of the file into the machine from cassette, validation of the fields on the screen according to the requirement, using the numeric check routine described earlier where appropriate, and storing the information collected back onto cassette. The same principle will work for a diskette serial file.

```
10 REM CUSTOMER
20 OPEN 4,4
30 REM DIMENSIONS FOR MAIN PROGRAM - CUSTOMER UPDA
   TE
40 DIM CN$(99),A$(99,4),P1$(99),D$(99,4),P2$(99),B
   L$(99)
50 REM DIMENSIONS FOR SCREEN HANDLING ROUTINE
60 DIM LI$(81),EN(20),EX(20),ST$(20)
```

```
70 TP=13
80 INPUT"LOAD CUSTOMER DATA";AN$
90 IFAN$="Y"THENGOSUB430
100 GOSUB980:CLOSE1
110 GOSUB1130:IFASC(CH$)=134THEN140
120 IFP=1ANDE=0THENNO=VAL(SN$):GOSUB590:GOTO110
130 GOSUB150:GOSUB1930:GOTO110
140 GOSUB760:CLOSE4:END
150 REM FUNCTION SUBROUTINE
160 W=1:GOSUB270
170 S1=NO
180 CN$(S1)=ST$(2)
190 FORQ=1TO4:A$(S1,Q)=ST$(2+Q):NEXT
200 P1$(S1)=ST$(7)
210 FORQ=1TO4:D$(S1,Q)=ST$(7+Q):NEXT
220 P2$(S1)=ST$(12)
230 W=13:GOSUB270
240 BL$(S1)=ST$(13)
250 FORV=1TO20:ST$(V)="":NEXT
260 RETURN
270 REM NUMERIC CHECK SUBROUTINE
280 REM IF VALID, NO IS RETURNED AS 'NO'
290 NO=VAL(ST$(W)):ST$=STR$(NO):TS$=ST$(W)
300 IFNO=0ANDLEN(TS$)=0THEN420
310 IFLEFT$(ST$,1)=" "THENST$=RIGHT$(ST$,LEN(ST$)-
     1):GOTO310
320 W1$=LEFT$(TS$,1):IFW1$="0"ORW1$=" "THENTS$=RIG
     HT$(TS$,LEN(TS$)-1):GOTO320
330 IFTS$=ST$THEN420
340 IFWS$="."THENWS$=" ":GOTO370
350 WS$=RIGHT$(TS$,1)
360 IFWS$=" "ORWS$="0"ORWS$="."THENTS$=LEFT$(TS$,L
     EN(TS$)-1):GOTO340
370 IFRIGHT$(TS$,1)=" "THENTS$=LEFT$(TS$,LEN(TS$)-
     1)
380 PRINT"[illegible]"
390 GOSUB 560
400 IFST$=TS$THEN420
410 IFST$<>TS$THENPRINT"]BAD DATA "ST$(W):E=1:GOTO
     110
420 E=0:RETURN
430 REM ROUTINE TO LOAD CUSTOMER DATA
440 PRINT"REMOVE PROGRAM & LOAD CUSTOMER TAPE"
450 OPEN1,1,0,"CUSTOMER"
460 INPUT#1,NO:IFNO=999THEN530
470 ST$(1)=STR$(NO)
480 FORW=2TOTP
490 INPUT#1,ST$(W)
500 IFST$(W)="*"THENST$(W)=""
510 NEXT
520 GOSUB150:GOTO460
530 PRINT"REMOVE CUSTOMER & LOAD SCREEN TAPE"
540 INPUT"TYPE RETURN WHEN READY";A$
550 CLOSE1:RETURN
560 REM LINE CLEAR ON SCREEN SUBROUTINE
570 FORZ=1TO40:PRINT" ";:NEXT
580 RETURN
590 REM FILL SCREEN WITH EXISTING INFO
600 CH$=""
610 W=1:GOSUB270
620 S1=NO
630 ST$(1)=STR$(S1)
640 ST$(2)=CN$(S1)
650 FORQ=1TO4:ST$(2+Q)=A$(S1,Q):NEXT
660 ST$(7)=P1$(S1)
670 FORQ=1TO4:ST$(7+Q)=D$(S1,Q):NEXT
680 ST$(12)=P2$(S1)
690 ST$(13)=BL$(S1)
700 PRINT"[illegible]"SPC(EN(1));
710 FORT=1TO20:IFLEN(ST$(T))>EX(T)THENST$(T)=RIGHT
     $(ST$(T),LEN(ST$(T))-1)
720 PRINTST$(T);:IFEN(T+1)=999THEN750
730 PRINTSPC(EN(T+1)-EN(T)-LEN(ST$(T)));
740 NEXT
750 RETURN
760 REM WRITE AWAY DATA SUBOUTINE
770 PRINT"]LOAD CUSTOMER TAPE"
780 OPEN1,1,1,"CUSTOMER"
790 FORNO=1TO99
800 IFCN$(NO)=""THEN940
810 PRINT#1,NO:PRINT#1,CN$(NO)
820 FORQ=1TO4:IFA$(NO,Q)<>""THENPRINT#1,A$(NO,Q):G
     OTO840
830 PRINT#1,"*"
840 NEXT
850 IFP1$(NO)<>""THENPRINT#1,P1$(NO):GOTO870
860 PRINT#1,"*"
870 FORQ=1TO4:IFD$(NO,Q)<>""THENPRINT#1,D$(NO,Q):G
     OTO890
880 PRINT#1,"*"
890 NEXT
900 IFP2$(NO)<>""THENPRINT#1,P2$(NO):GOTO920
910 PRINT#1,"*"
920 IFBL$(NO)<>""THENPRINT#1,BL$(NO):GOTO940
930 PRINT#1,"*"
940 NEXT
950 PRINT#1,999
960 CLOSE1
970 PRINT"CUSTOMER TAPE UPDATED":RETURN
980 REM BUILD SCREEN SUBROUTINE
990 R=1:T=1:OF=1023:CF=55295:SC$="SCREEN"
1000 PRINT"LOAD SCREEN TAPE"
1010 OPEN1,1,0,SC$:PRINT"]"
1020 INPUT#1,A,A$:IFA=999THENEN(T)=A:RETURN
```

```
1030 AC=ASC(MID$(A$,R,1)):PK=AC
1040 IFAC>63THENPK=AC-64
1050 IFAC>95THENPK=AC-32
1060 POKEOF+A+R,PK
1070 POKECF+A+R,1
1080 IFLEN(A$)=1ANDA$="("THENEN(T)=A+1
1090 IFLEN(A$)=1ANDA$=")"THENEX(T)=A-EN(T):T=T+1
1100 IFR=LEN(A$)THENR=1:GOTO1020
1110 R=R+1:GOTO1030
1120 RETURN
1130 REM ACCEPT INPUT SUBROUTINE
1140 REM 'P' IS THE START POSITION OF THE CURRENT
     LINE.
1150 REM 'I' IS THE CURRENT POSITION IN THE LINE.
1160 REM 'J' IS THE CURRENT POSITION IN THE PRINT
     LINE WHEN PRINTING.
1170 REM 'LC' IS THE LAST CHARACTER POSITION IN TH
     E CURRENT LINE.
1180 REM 'N' IS A POSITION IN THE CURRENT LINE USE
     D DURING LINE MANIPULATION.
1190 REM 'LI$()' IS AN ARRAY OF 80 SINGLE CHARS, E
     ACH REPRESENTING ONE LINE PSN
1200 REM 'FL' IS THE CURSOR.
1210 I=0:P=1:CH$=" "
1220 PRINT"☒▣";
1230 FORQ=1TOEN(P):PRINT"▮";:NEXT
1240 FL$(1)="✱":FL$(2)=" "
1250 REM NEXT FIELD ENTRY POINT
1260 LC=LEN(ST$(P))
1270 IFLC<>0THENFORN=1TOLC:LI$(N)=MID$(ST$(P),N,1)
     :NEXT
1280 IFASC(CH$)=133THEN1550
1290 REM NEXT CHAR ENTRY POINT
1300 IFLC<ITHENLC=I
1310 IFLC>ITHENFL$(2)=LI$(I+1):IF ASC(LI$(I+1))=34
     THENFL$(2)="☒'▀"
1320 IFLC=ITHENFL$(2)=" "
1330 IFI>=EX(P)THENCH$=CHR$(13):GOTO1550
1340 FORL=1TO2
1350 FORK=1TO30
1360 GETCH$:PRINTFL$(L)"▮";
1370 IFCH$<>""THEN1410
1380 NEXT
1390 NEXT
1400 GOTO1300
1410 PRINTFL$(2)"▮";:IFASC(CH$)=20THEN1660
1420 IFASC(CH$)=148THEN1750
1430 IFASC(CH$)=157THEN1860
1440 IFASC(CH$)=29THEN1900
1450 IFASC(CH$)=133THEN1550
1460 IFASC(CH$)=134THENRETURN
1470 IFASC(CH$)=135THENRETURN
1480 IFASC(CH$)=13ORASC(CH$)=141THEN1550
1490 IFASC(CH$)<32THEN1290
1500 IFASC(CH$)>127ANDASC(CH$)<160THEN1290
1510 CA$=CH$
1520 IFASC(CH$)=34THENCA$="☒'▀"
1530 I=I+1:PRINTCA$;:LI$(I)=CH$:GOTO1290
1540 LI$(I)=CH$
1550 REM STOREING
1560 SN$=""
1570 IFEN(P+1)<>999THENFORQ=EN(P)+ITOEN(P+1)-1:PRI
     NT"▮";:NEXT
1580 FORJ=1TOLC+1
1590 SN$=SN$+LI$(J):LI$(J)="":NEXT
1600 ST$(P)=SN$:IFP<>1GOTO1620
1610 IFCN$(VAL(SN$))<>""ANDE=0THENGOSUB590:PRINT"☒
     "SPC(EN(2));:CH$=" "
1620 P=P+1
1630 I=0:LC=0
1640 IFEN(P)=999THENRETURN
1650 GOTO1250
1660 REM  DELETE
1670 I=I-1:IFI<0THENI=0:GOTO1290
1680 LC=LC-1
1690 PRINTCH$;
1700 FORN=2TOEX(P)-I:PRINT"▮";:NEXT:PRINT" )";
1710 FORN=0TOEX(P)-I:PRINT"▮";:NEXT
1720 FORN=I+1TOLC+1:LI$(N)=LI$(N+1)
1730 NEXT
1740 GOTO1290
1750 REM INSERT
1760 PRINT " ";:LC=LC+1:LI$(LC)=" "
1770 FORN=I+1TOLC
1780 IFASC(LI$(N))=34THENPRINT"☒'▀";
1790 IFASC(LI$(N))<>34THENPRINTLI$(N);
1800 NEXT
1810 FORN=ITOLC:PRINT"▮";:NEXT
1820 FORN=LCTOI+1STEP-1:LI$(N)=LI$(N-1)
1830 NEXT
1840 LI$(I+1)=" "
1850 GOTO1290
1860 REM CURSOR <-
1870 I=I-1:IFI<0THENI=0:GOTO1290
1880 PRINT"▮";
1890 GOTO1290
1900 REM CURSOR ->
1910 I=I+1:IFI>LCTHENLI$(I)=" "
1920 PRINTFL$(2);:GOTO1290
1930 REM CLEAR ENTRIES SUBROUTINE
1940 PRINT"☒";:FORR=1TOEN(1):PRINT"▮";:NEXT
1950 FORU=1TOT
1960 IFEX(U)<>0THENFORR=1TOEX(U):PRINT" ";:NEXT
1970 IFEN(U+1)<>999THEN:FORR=1+EN(U)+EX(U)TOEN(U+1
     ):PRINT"▮";:NEXT
```

```
1980 NEXT
1990 PRINT"[illegible]"
2000 GOSUB560
2010 RETURN
2020 OPEN 1,1,0,"CUSTOMER"
2030 INPUT#1,A$
2040 PRINT A$
2050 INPUT B$
2060 IFB$="Y"GOTO2030

READY.
```

Another useful little routine for business programs is a date routine for displaying todays date in the top right hand corner of the screen. The parts you want can be selected from the program below which operates on a VIC 20.

```
100 rem ***************
110 rem **           **
120 rem **date-vic20 **
130 rem **           **
140 rem ***************
150 vl=36878:sb=36879:s3=36826:rem define colour &
     sound
160 print "[illegible]":poke sb,186
170 print "**********************"
180 print "* enter today's date *"
190 print "**********************"
200 dim m$(12)
210 for m=1 to 12:read m$(m):next
220 data jan,feb,mar,apr,may,jun,jul,aug,sep,oct,n
     ov,dec
230 :
240 input"day";a$:a=val(a$)
250 input "month";b$:b=val(b$)
260 if a=0 then print "invalid day":goto 420
270 if b=0 then print "invalid month":goto420
280 on b goto 310,300,310,330,310,330,310,310,330,
     310,330,310
290 :
300 if a>29 then print "invalid day":goto 420
310 if a>31 then print "invalid day":goto420
320 goto 350
330 if a>30 then print "invalid day":goto420
340 goto 350
350 if b>12 then print "invalid month":goto420
360 input "year";c$:c=val(c$)
370 if c/4<>int(c/4) and a>28 then print "invalid
     day":goto 420
380 if left$(c$,2)<>"19" then c$="19"+c$:c=1900+c
390 if 1984>c then print "invalid year":goto 420
400 goto 530
410 :
420 rem *********
430 rem * bleep **
440 rem *********
450 poke vl,15
460 poke 36876,225
470 for n=1 to 500
480 next
490 poke vl,0
500 poke s3,0
510 goto 240
520 :
530 print"[illegible]";
540 poke sb,27:rem restore to normal colours
550 print a$"/"b$"/"c$

ready.
```

Many people use spreadsheet programs and you can buy one of the standards on the market. However, if you wish to play around with the idea, this program may help:

```
5 REM DATA
10 ND=10
20 SC=53281:BD=53280:POKE SC,1
30 POKE 650,128:REM ** REPEAT KEYS **
40 DIM DT$(12,10),MN$(12),T(12)
50 FOR MN=1 TO 12:READ MN$(MN)
60 MN$(MN)="[illegible]"+MN$(MN)+"[illegible]":NEXT
70 DATA JANUARY,FEBRUARY,MARCH,APRIL,MAY,JUNE,JULY
     ,AUGUST,SEPTEMBER,OCTOBER
80 DATA NOVEMBER,DECEMBER
90 OPEN 1,0:PRINT"[illegible]"
100 PRINT"[illegible]GET DATA FROM TAPE OR ENTER?"
105 PRINT "ENTER NO. MONTH TO START ENTERING AT"
110 INPUT#1,TE$:PRINT:PRINT
114 MB=VAL(TE$):IF MB=0 OR MB>12 THEN MB=1
115 IF LEFT$(TE$,1)<>"T" THEN 190
120 OPEN 2,1,0,"DATA":FOR MN=1TO12:FORDT=1TOND:INP
     UT#2,DT$(MN,DT)
130 IF DT$(MN,DT)="*" THEN 170
140 T(MN)=T(MN)+VAL(DT$(MN,DT)):NEXT DT,MN:CLOSE2
150 IF MN>12 THEN 250
160 FOR MN=MN TO 12:FOR DT=1 TO ND:IF LEN(DT$(MN,D
     T))=0THENDT$(MN,DT)=" "
170 NEXT DT,MN:GOTO 250
180 :
190 FOR MN=MBTO 12
200 PRINT MN$(MN)
```

```
210 FOR DT=1 TO ND
220 INPUT#1,DT$(MN,DT):PRINT
230 IF DT$(MN,DT)="*" THEN 150
240 T(MN)=T(MN)+VAL(DT$(MN,DT)):NEXT DT,MN
250 PRINT"▯"
260 :
265 REM ********************************
266 REM ****  WHAT MONTH?           ****
267 REM ********************************
270 PRINT"▯MONTH(ENTER NO 1-12/T FOR TAPE OUTPUT)
   ?"
280 PRINT "     ";:INPUT#1,MB$
290 IF MB$="*" THEN RUN
291 IF MB$="T" THEN GOSUB 430:GOTO 265
300 MB=VAL(MB$):IF MB=0 OR MB>12 THEN MB=1
310 PRINT"▯"
320 FOR N=0 TO 2:MN=MB+N
330 IF N=2 AND MN=13 THEN MN=1
340 IF MN=13 THEN MB=0:MN=MB+N
350 PRINT "▯";TAB((N)*13);MN$(MN)
360 FOR DT=1 TO 10
370 PRINT TAB((N)*13);DT$(MN,DT)
380 NEXT DT
385 PRINT TAB((N)*13);"───"
387 PRINT TAB((N)*13);T(MN)
390 NEXT N
392 PRINT:PRINT:PRINT
395 GOTO 265
396 :
400 REM********************************
410 REM*****     TAPE OUTPUT      *****
420 REM********************************
430 OPEN 2,1,1,"DATA"
440 FOR MN=1 TO 12
450 FOR DT=1 TO 10
460 PRINT#2,DT$(MN,DT):CHR$(13)
470 IF DT$(MN,DT)="*" THEN 490
480 NEXT DT,MN
490 CLOSE 2:RETURN

READY.
```

The program uses a 2 dimensional array to hold information for each month of the year, and totals the information by month. The data is read from tape if required, and can be stored again on tape afterwards.

TAPE HANDLING

The two programs below are a pair for programmed learning. The first, TEACHER allows questions and multiple choice answers to be set up on a tape. The second, PUPIL allows the pupil to be tested and scored against the data set up on tape.

```
10 REM TEACHER
20 OPEN4,4
30 DIMLI$(191)
40 SB=36879:A=1
50 POKESB,26
60 PRINTCHR$(14)"▯    ●╱▔●│╲┌╱ ●▔│"
70 PRINT"     ──────────────"
80 INPUT"▔RINTER Y OR N":PR$
90 PRINT"LOAD DATA TAPE, PRESS _ECORD & ▔LAY"
100 WAIT37151,64,64
110 OPEN1,1,1,"DATA"
120 PRINT"▯●UESTION"A"■"
130 GOSUB470
140 QU$=SR$
150 REM TEST FOR END OF PROGRAM.
160 IFLEFT$(QU$,1)="*"THEN400
170 REM SET UP CORRECT ANSWER.
180 PRINT"▯♠NSWER■"
185 PRINT"  ";
190 GOSUB470
200 AN$=SR$
210 REM SET UP ALTERNATIVE ANSWERS.
220 FORM=1TO3
230 PRINT"▯ORONG ALTERNATIVE■"
235 PRINT"  ";
240 GOSUB470
250 WR$(M)=SR$
260 IFLEFT$(WR$(M),1)="*"THEN290
270 NEXTM
280 M=M-1
290 IFM=1THENPRINT"▯/O ALTERNATIVES!■":GOTO220
300 PRINT#1,QU$
310 PRINT#1,AN$
320 FORP=1TOM:PRINT#1,WR$(P):NEXTP
330 IFPR$<>"Y"THEN380
340 PRINT#4,CHR$(17)"●UESTION "A"  "QU$
350 PRINT#4,CHR$(17)"♠NSWER " AN$
360 PRINT#4,CHR$(17)"ORONG ♠LTERNATIVES"
370 FORP=1TOM:PRINT#4,CHR$(17)WR$(P):NEXTP
380 A=A+1
390 GOTO120
400 PRINT#1,QU$
410 PRINT"▔ROGRAM COMPLETE."
420 PRINTA-1"●UESTIONS SET"
```

```
430 CLOSE1
440 CLOSE4
450 PRINT"●TOP TAPE, REWIND AND LABEL"
460 END
470 REM LINE SETTING UP SUBROUTINE
480 I=0:LC=0
490 FL$(1)="▒":FL$(2)=" "
500 REM MAIN LOOP
510 IFLC<ITHENLC=I
520 IFLC>ITHENFL$(2)=LI$(I+1):IFASC(LI$(I+1))=34TH
     ENFL$(2)="▧'■"
530 IFLC=ITHENFL$(2)=" "
540 IFLC>189THENCH$=CHR$(13):GOTO720
550 FORL=1TO2
560 FORK=1TO30
570 GETCH$:PRINTFL$(L)"▮▮";
580 IFCH$<>""THEN620
590 NEXTK
600 NEXTL
610 GOTO510
620 PRINTFL$(2)"▮▮";:IFASC(CH$)=20THEN780
630 IFASC(CH$)=148THEN850
640 IFASC(CH$)=157THEN960
650 IFASC(CH$)=29THEN1000
660 IFASC(CH$)=13ORASC(CH$)=141THEN720
670 IFASC(CH$)<32THEN500
680 IFASC(CH$)>127ANDASC(CH$)<160THEN500
690 CA$=CH$
700 IFASC(CH$)=34THENCA$="▧'■"
710 I=I+1:PRINTCA$;:LI$(I)=CH$:GOTO500
720 REM***************        ** LINE SET  **
      ***************
730 PRINT:SR$=""
740 FORJ=1TOLC+1
750 SR$=SR$+LI$(J):LI$(J)="":NEXT J:
760 PRINT
770 RETURN
780 REM***************        **   DELETE  **
      ***************
790 I=I-1:IFI<0THENI=0:GOTO500
800 LC=LC-1
810 PRINTCH$;
820 FORN=I+1TOLC+1:LI$(N)=LI$(N+1)
830 NEXTN
840 GOTO500
850 REM***************        **   INSERT  **
      ***************
860 PRINT" ";:LC=LC+1:LI$(LC)=" "
870 FORN=I+1TOLC
880 IFASC(LI$(N))=34THENPRINT"▧'■";
890 IFASC(LI$(N))<>34THENPRINTLI$(N);
900 NEXTN
910 FORN=ITOLC:PRINT"▮▮";:NEXTN
920 FORN=LCTOI+1STEP-1:LI$(N)=LI$(N-1)
930 NEXTN
940 LI$(I+1)=" "
950 GOTO500
960 REM***************        ** CURSOR <- **
      ***************
970 I=I-1:IFI<0THENI=0:GOTO500
980 PRINT"▮▮";
990 GOTO500
1000 REM***************        ** CURSOR -> **
      ***************
1010 I=I+1:IFI>LCTHENLI$(I)=" "
1020 PRINTFL$(2);:GOTO500

READY.
```

```
10 REM PUPIL
20 SB=36879:N=1
30 POKE SB,29
40 PRINTCHR$(14)"⊐        |‾●| "
50 PRINT"         ▬▬▬"
60 PRINT"LOAD QUESTION TAPE &  PRESS ⌐L♠|"
70 WAIT37151,64,64
80 OPEN1,1,0,"DATA"
90 REM GET INITIAL DATA
100 GOSUB500
110 REM GET THE QUESTION
120 QU$=RI$(1)
130 IFLEFT$(QU$,1)="*"THEN430
140 AN$=RI$(2)
150 FORJ=1TO4
160 WR$(J)=" "
170 NEXTJ
180 WR$(Q-1)=AN$
190 FORM=1TOQ-2
200 WR$(M)=RI$(M+2)
210 NEXTM
220 PRINT"⊐    ●UESTION"N
230 PRINT "    ▬▬▬▬▬▬▬▬▬"
240 PRINT"▧"QU$"■"
250 REM RANDOMISE THE ANSWER POSITION IN THE LIST
260 A=INT(RND(1)*(Q-1)+1)
270 CR=Q-A
280 FORK=1TOQ-1
290 PRINT"▆▮"K"■";WR$(A)
300 A=A+1:IFA>Q-1THENA=1
310 NEXTK
320 REM LOAD NEXT FROM TAPE BEFORE ACCEPTING ANSWE
    R
330 GOSUB500
```

```
340 INPUTAN$
350 AN=VAL(AN$)
360 REM SCORING, WR = NO. WRONG; RI = NO. RIGHT.
370 IFAN=CRTHENRI=RI+1:PRINT"■CORRECT■":T=999
380 IFAN<>CRTHENWR=WR+1:PRINT"■RONG -■":T=2000
390 PRINT"  "WR$(R-1)
400 N=N+1
410 FORK=1TOT:NEXTK
420 GOTO110
430 PRINT"■EST COMPLETE.■"
440 PRINT N-1"■UESTIONS ANSWERED■"
450 PRINTRI" CORRECT■"
460 PRINTWR" WRONG■"
470 CLOSE1
480 PRINT "■RESS STOP ON TAPE"
490 END
500 REM GET NEXT
510 R=Q
520 GOSUB580:RI$(1)=SR$
530 IFLEFT$(RI$(1),1)="*"THEN570
540 FORQ=2TO5:GOSUB580:RI$(Q)=SR$:IFLEFT$(RI$(Q),1
   )="*"THEN560
550 NEXT
560 Q=Q-1
570 RETURN
580 SR$=""
590 GET#1,IN$:SR$=SR$+IN$
600 IFIN$=CHR$(13)ORIN$=CHR$(141)THENRETURN
610 GOTO590

READY.
```

PRINTING

A screen dump program is always useful to produce on the printer a copy of what is at present on the screen.

```
10 REM PRINT SCREEN (TOP 22 LINES)
20 SC=1024:OPEN4,4:CMD4:PRINT CHR$(14);
30 FOR Y=0 TO 22
40 FOR X=0 TO 39
50 PK=PEEK(X+(Y*40)+SC):LE=PK
55 IF PK>127 THEN PK=PK-128:PRINT CHR$(18);
60 IF PK=96 THEN LE=32:GOTO 150
70 IF PK<32 OR PK>96 THEN LE=PK+64:GOTO 150
80 IF PK<96 AND PK>63 THEN LE=PK+32:GOTO 150
90 IF PK>96 THEN LE=PK+64
150 PRINT CHR$(LE)CHR$(146);
160 NEXT X:PRINT:NEXT Y
170 PRINT#4:CLOSE4:END

READY.
```

GAME

Every book has to have at least one game. Here are two, one for the CBM 64 and the second for the VIC 20 No further explanation is required (or will be given)!

```
10 REM ********************************
20 REM ********************************
30 REM ***                          ***
40 REM *** CAR CHALLENGE            ***
50 REM ***                          ***
60 REM ***      BY M & T HILL       ***
70 REM ***                          ***
80 REM ********************************
90 REM ********************************
100 SC=53281:POKE SC,1
110 PRINT"■■■■■■■■■■***** ■CAR CHALLENGE■ *****"
120 PRINT "■■■■■■■■■■■■■■HIGH SCORE =";HI
130 PRINT "■■■■■■■■■■■■■■THERE ARE 9 LEVELS, 9 BEIN
   G THE         EASIEST, AND 1";
140 PRINT " THE MOST DIFFICULT"
150 PRINT "■■■■■■■■■■■■■■■■■■■■■■■■LEVEL OF DIFFICU
   LTY:"
160 PRINT TAB(20);
170 GET KY$:IF VAL(KY$)=0 THEN 170
180 L=VAL(KY$):PRINT KY$
190 :
200 :
210 POKE 650,128:REM:SET REPEAT KEYS ON FOR ALL KE
   YS
220 BD=53280 POKE BD,L
230 CR=1637:CL=55296-1024:V=81:TV=81:G=1
240 :
250 :
260 :
270 REM *** START UP  ***
280 :
290 PRINT "■■■■ LEVEL:=■"L;"■HI SCORE:=■";HI;"■GO:
   =";G
300 CR=1637:REM ** RESET CAR POS ***
310 POKE CR,V:POKE CR+CL,0:TI$="000000"
320 A$="■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■      ■■■■■■■■■■■
   !"
```

```
330 FOR N=1 TO 13:PRINT:PRINT RIGHT$(A$,LEN(A$)-25
    ):NEXT
340 PRINT "      ├----START-----|┐"
350 FOR N=1 TO 9:PRINT:PRINT RIGHT$(A$,LEN(A$)-25)
    :NEXT
360 GET KY$:IF KY$<>"" THEN 360
370 FOR N=1 TO 1000:NEXT
380 X=0
390 :
400 REM *****************************
410 REM ****** THE PROG ITSELF ******
420 REM *****************************
430 :
440 GOSUB 670:REM *** PRINT ROAD ***
450 IF CH=2 THEN CH=0:GOTO 510
460 :
470 GOSUB 770:REM *** MOVE CAR ***
480 :
490 GOTO 410
500 :
510 REM ****** ENDING  *****
520 PRINT "┬┬▮┬WIT!!"
530 SC=VAL(TI$)*(10-L)
540 PRINT "▒"SC:IF SC>HI THEN HI=SC
550 FOR N=1 TO 2000:NEXT
560 X=0:G=G+1
570 GOTO 270
580 :
590 REM ****** SHAPES ON ROAD *****
600 B$="*     *":RETURN
610 B$="o     o":RETURN
620 B$="▒▒     ▒":RETURN
630 B$="♠     ♠":RETURN
640 B$="▒+     +":RETURN
650 B$="▮x     x":RETURN
660 :
670 REM ****** PRINTING ROAD *****
680 X=X+1
690 IF X<>L THEN PRINT:GOTO 730
700 RD=INT(RND(1)*6)+1
710 ON RD GOSUB 600,610,620,630,640,650
720 PRINT TAB(6+INT(RND(5)*9));B$:X=0
730 :
740 PRINT A$
750 RETURN
760 :
770 REM **** MOVE CAR ****
780 IF PEEK(CR)<>32 AND PEEK(CR)<>V THEN CH=2:RETU
    RN
790 GET KY$
800 IF KY$="Z" THEN CR=CR-1
810 IF KY$="M" THEN CR=CR+1
```

```
820 IF KY$="▀" THEN GOTO 100
830 POKE CR,V:POKE CR+CL,0
840 RETURN

READY.

1 V=36878:S1=36874:SC=36879:POKE V,10:S2=S1+1:S3=S
    2+1
2 A=7680:POKESC,27:D1$="▮▮▮▮▮▮▮▮▮▮▮":D3$="▮▮▮▮▮":A
    1$="▮▮▮▮▮▮▮▮▮▮":A2$="▮▮▮▮▮"
3 D2$="▮▮▮▮▮▮▮▮▮▮▮":HA$="┐▮********▒HANGMAN▮▮******
    ":ST$="************"
4 IF PEEK(4096)<>0 THEN A=4096
5 B=B+1:READWO$:IFWO$=""THEN7
6 GOTO5
7 GOSUB72
8 L=0:RESTORE:RD=INT(RND(1)*B)
9 FORN=0TORD:READWO$:NEXT
10 LN=LEN(WO$):PRINTHA$:PRINTD3$"▮▮▮"A1$;
11 FORN=1TOLN:PRINT"▒";:NEXTN:TI$="000000"
12 FORN=1TO100:NEXT
13 POKES1,0:POKESC,27:GETKY$:IFKY$=""THEN13
14 FORN=1TOLN
15 IFKY$=MID$(WO$,N,1)THENPOKES1,250:POKESC,255:GO
    TO22
16 NEXTN:FORN=1TOLN
17 IFKY$=MID$(WO$,N,1)THENGOTO13
18 NEXT:PRINTD1$;D2$;A2$"▮";:L=L+1:POKES1,150:POKE
    SC,24
19 FORN=0TOL:PRINT"▮";:NEXT:PRINTKY$
20 ONLGOSUB27,28,29,30,31,32,33,34,35,36,37,38,39,
    40,41
21 GOTO12
22 PRINTD1$;A1$"▮";
23 FORX=1TON:PRINT"▮";:NEXT:PRINTKY$
24 FORX=A+230TOA+230+LN:IFPEEK(X)=102THEN26
25 NEXT:GOTO46
26 N=N+1:GOTO15
27 PRINTD1$;D2$"▮ ────":RETURN
28 PRINTD1$;D2$"▮┌":RETURN
29 PRINTD1$;D2$;A2$"▮┐":RETURN
30 PRINTD1$;D2$"   ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ |":RE
    TURN
31 PRINTD1$;D2$"▮▮▮▮╲▮▮▮╲":RETURN
32 PRINT D1$"▮▮▮▮▮/┐/":RETURN
33 PRINTD1$"▮▮▮L___":RETURN
34 PRINTD1$;A2$"▮|▮▮|":RETURN
35 PRINTD1$;A2$"▮▮▮O":RETURN
36 PRINTD1$;A2$"▮▮▮▮╲":RETURN
37 PRINTD1$;A2$"▮▮▮▮/":RETURN
38 PRINTD1$;D3$;A2$"┐▮ ▀":RETURN
39 PRINTD1$;D3$"▮▮▮▮/":RETURN
```

```
40 PRINTD1$;D3$;A2$"▮\":RETURN
41 POKESC,24:POKES1,128:PRINTD1$;A1$"▮▮"WO$:FORN=1
    TO10
42 FORX=1TO100:NEXTX:PRINTD1$"▮▮▮▮▮▮\▮/":PRINTD1$
    ;D3$"▮▮▮▮▮ ▮ "
43 FORX=1TO100:NEXTX:PRINTD1$"▮▮▮▮▮▮ ▮ ":PRINTD1$
    ;D3$"▮▮▮▮▮/▮\"
44 NEXTN:FORX=1TO1000:NEXT:POKES1,0:IFSE>0THENSE=0

45 PRINT"▮"D2$"▮▮▮▮YOU HAVE LOST!!":GOTO56
46 POKES1,0:FORI=1TO1000:NEXT:PRINT"▮▮"D2$;A2$"▮"S
    T$;A1$"*            *"
47 PRINTD1$;A2$"▮*WELL DONE!*"
48 PRINTD1$;A2$"▮▮*              *"A1$;ST$:FORN=128TO2
    55STEP3
49 POKESC,N:POKES3,N
50 FORX=1TO100:NEXTX:NEXTN:POKES3,0:POKESC,27:SE=S
    E+INT(550-VAL(TI$))-(L*50)
51 SE=INT(SE/10):SE=SE*10
52 PRINT"▮▮▮"A2$;ST$A1$"*"SPC(10)"*"
53 PRINT"▮"A2$"▮▮*WELL DONE!*"
54 PRINT"▮▮▮▮▮"A2$"*"SPC(10)"*"A1$;ST$
55 PRINT"▮▮YOU NOW HAVE A SCORE  OF:":PRINT A1$;SE
56 PRINT"▮▮▮WOULD YOU LIKE ANOTHERGO?"
57 GETKY$:IFKY$<>"N"ANDKY$<>"Y"THEN57
58 IFKY$="Y"THEN8
59 PRINT"GOOD BYE!!":FORN=1TO1000:NEXT:PRINT"▮▮":P
    OKES1,0:POKES2,0
60 POKES3,0:POKESC,27:END
61 DATAFISH,CAR,ABACK,WATER,FINISH,TABLE,CARPET,VA
    SE,FLOWER,DESK,CURTAIN
62 DATARETURN,CUP,FORK,KNIFE,PAN,CUPBOARD,PICTURE,
    PLANT,BOOK,BLOCK,FIRE,ICE
63 DATARADIO,LIGHT,TELEVISION,CASSETTE,BECAUSE,WHE
    N,WHERE,THERE,THEIR,FOSSIL
64 DATASNOOKER,SCHOOL,FEATHER,TEACHER,WORK,PLAY,BE
    D,QUILT,ROAD,FATHER
65 DATAMOTHER,SON,SUN,DAUGHTER,COUSIN,SWITCH,APPLE
    ,ORANGE,PEAR,BANANA
66 DATAWALLPAPER,RUG,FURNITURE,BIKE,CYCLE,MOTOR,BU
    LB,GLASS,DOOR,ATLAS
67 DATAGAS,BRICK,YELLOW,RED,WHITE,LEAF,LEAVES,MARO
    ON,BROWN,BLUE,RAIN,WINDOW
68 DATAPINK,INDIGO,PURPLE,BLACK,GREEN,VIOLET,LEMON
    ,LILAC,GREY,RUST
69 DATAPEN,PENCIL,DRUM,TRUMPET,PIANO,VIOLIN,FOLLY,
    WELLINGTON,SOCK,SHIRT
70 DATAVEST,JUMPER,TIE,TROUSERS,BLOUSE,TEETH,EYES,
    EARS,MOUTH,NOSE,LEG,ARM
71 DATAFEET,THINK,
72 PRINTHA$:POKESC,27
73 PRINT"▮▮YOU MUST DECIPHER THEWORD IN THE BLOCK
    OF  ▮▮▮▮'S.IF YOU FAIL,"
74 PRINT"YOU HANG:"
75 FORN=1TO3000:NEXT:POKESC,24
76 L=L+1:ONLGOSUB27,28,29,30,31,32,33,34,35,36,37,
    38,39,40
77 IFL<15THEN76
78 POKES1,128:FORX=1TO15
79 FORN=1TOX*20:NEXTN
80 PRINTD1$;A2$"▮▮▮\O/"
81 PRINTD1$;A2$"▮▮▮▮ ▮ "
82 FORN=1TOX*20:NEXTN
83 PRINTD1$;A2$"▮▮▮ O "
84 PRINTD1$;A2$"▮▮▮▮/▮\":NEXTX
85 POKE S1,0:FOR N=1 TO 2000:NEXT N
86 PRINTHA$:POKESC,27
87 PRINT"▮IF YOU WIN,YOU SCORE:"
88 PRINT"▮▮▮":FORN=1TO1000:NEXTN:POKESC,31
89 FORX=0TO300STEP10
90 FORN=1TO100:NEXTN:POKES1,(X/10)+220
91 PRINTA2$"▮▮SCORE =";X:NEXTX:FORN=1TO500:NEXT
92 PRINTA2$"▮▮▮▮HIT ANY KEY▮":POKES1,0:FORN=1TO10
    0:NEXT
93 GETKY$:IFKY$=""THEN93
94 RETURN

READY.
```

GRAPH PLOTTING

This program plots a low resolution graph with offsets. It is useful to show whether there are trends before going into more sophisticated analysis.

```
10 REM LOW RES GRAPH PLOT WITH OFFSET X AND Y AXES

20 REM ITEMS TO BE PLOTTED ARE HELD IN X() AND Y()

30 REM MX IS MAX VALUE OF X FOUND IN ARRAY
40 REM NX IS MIN VALUE OF X FOUND IN ARRAY
50 REM SIMILARLY FOR MY AND NY
60 REM NA IS MAX NO. OF ITEMS TO BE PLOTTED
65 Q=1:DEF FNA(X)=(INT((X*Q)+.5))/Q
66 DIM X(20),Y(20)
70 :
76 FOR I=1 TO 20
77 INPUT "X,Y";X(I),Y(I):IF X(I)=-999 OR Y(I)=-999
     THEN 79
78 NEXT
79 MX=0:MY=0:NX=X(1):NY=Y(1):REM INITIALISE LIMITS
```

```
80 FOR J=1 TO 20
90 IF X(J)=-999 OR Y(J)=-999 THEN NA=J-1:GOTO 150:
     REM END OF ENTRIES IN X OR Y
100 IF X(J)>MX THEN MX=X(J):REM PUSH UP MAX IF REQ
     UIRED
110 IF Y(J)>MY THEN MY=Y(J):REM DITTO
120 IF X(J)<NX THEN NX=X(J):REM PUSH DOWN LOWER LI
     MIT IF REQUIRED
130 IF Y(J)<NY THEN NY=Y(J):REM DITTO
140 NEXT J
150 PRINT "▜"
160 FOR I=1 TO 20:PRINT " |":NEXT:REM SET UP VERTI
     CAL LEFT LINE FOR Y AXIS
170 PRINT"▜"
180 FOR I=1 TO 38:PRINT "▄";:NEXT:PRINT:REM SET U
     P HORIZONTAL LINE FOR X AXIS
189 REM X-AXIS
190 PRINT FNA(NX);
200 PRINT TAB(35)FNA(MX)
201 REM Y-AXIS
202 PRINT "▓"
203 MY$=STR$(FNA(MY)):FOR I=1 TO LEN(MY$):PRINT MI
     D$(MY$,I,1):NEXT I
204 FOR K=LEN(MY$)-1 TO 15:PRINT:NEXT K
205 NY$=STR$(FNA(NY)):FOR I=1 TO LEN(NY$):PRINT MI
     D$(NY$,I,1):NEXT I
210 PRINT"▓"
215 REM GRAPH ITSELF
220 FOR J=1 TO NA
230 X=X(J):Y=Y(J)
240 YP=19-19*(Y-NY)/(MY-NY):XP=2+(X-NX)*35/(MX-NX)

250 FOR L=1 TO YP:PRINT"▓";:NEXT L
260 PRINT TAB(XP);"+"
270 PRINT "▓"
280 NEXT J
290 PRINT"▓":GOTO 290:REM HOLD TO PREVENT 'READY'S
     POILING GRAPH
300 REM CHANGE 290 TO EXIT TO NEXT PART OF YOUR PR
     OGRAM

READY.
```

High resolution graphics can be slow but obviously will give a more precise picture than anything constructed above. One of the restrictions of CBM BASIC is that there are no language commands for graphics, sound or colour and all this manipulation has to be done by use of **POKE** commands. This is illustrated by the high resolution graphics program below, for the CBM 64, which will draw a curve represented by the formula entered in the formula section, in this case a circle. Note that the X-like symbol in the listing *is in* fact Π. Π is only shown in the cursor up mode of listing.

```
100 rem hi9h resolution Plottin9 on screen (or 152
     0 Printer)
110 sc=53281:bd=53280:rem define screen and border
      clour variables
120 Poke sc,1:Poke bd,6:Print "▓▓"
130 Poke 650,128:rem key rePeat
140 oPen 1,6,1:rem 9raPhics Printer (1520) if avai
     lable
150 :
160 bm=8192:Px=1:rem bitmaP (bm) and Pixel on/off
170 Print "clear screen?"
180 9et ky$:if ky$="" then 180
190 :
200 :
210 Poke 53272,Peek(53272) or 8:rem switch disPlay
      screen to location of bit maP
220 Poke 53265,Peek(53265) or 32
230 rem enter bit maP 2 colour inPutmode (bit 5 of
      vic 2 chiP)
240 for i=1024 to 2023:Poke i,1:next
250 :
260 if ky$="n" or ky$="N" then 300
270 for i=bm to bm+7999
280 if Peek(i)<>0 then Poke i,0
290 next
300 :
310 Poke 53280,3
320 :
330 for x=-10 to 10:y=0:9osub 520:next
340 for y=-10 to 10:x=0:9osub 520:next
350 Poke bd,5
360 rem ******************************
370 rem ***      formula            ***
380 rem ******************************
390 r=256
400 :
410 for l=0 to 360 steP 10:rem steP trades sPeed f
     or resolution
420 :
430 r=80:rem *** radius
440 x=r*sin(l*╳/180)
450 y=r*cos(l*╳/180)
```

```
460 :
470 gosub 520
480 next
490 :
500 goto 810:rem menu
510 :
520 rem ******************************
530 rem ***    setting pixel       ***
540 rem ******************************
550 gosub 910:poke pk,p
560 return
570 :
580 rem ******************************
590 rem ***      re-set            ***
600 rem ******************************
610 poke 53265,peek(53265) and 223
620 poke 53272,21                  :rem ** set char
     set pointer
630 print "██hi there"
640 return
650 :
660 rem ******************************
670 rem ***       printout         ***
680 rem ******************************
690 poke bd,2
700 :
710 for y=0 to 199
720 for x=0 to 319
730 gosub 910
740 p=peek(pk)
750 if p=(p or (2↑bit)) then print#1,"m";x-1,-1*y:
     print#1,"d";x,-1*y
760 next x,y
770 :
780 poke bd,5
790 return
800 :
810 rem *****************************
820 rem ***    last menu          ***
830 rem *****************************
840 poke bd,7
850 get ky$:if ky$="" then 850
860 if ky$="p" then 660
870 if ky$="x" then gosub 580:end
880 if ky$="r" then run
890 goto 850
900 :
910 rem *****************************
920 rem ***    setting position    **
930 rem *****************************
940 :
950 xx=x+160
960 yy=100-y:rem invert graph
970 col=int(xx/8):row=int(yy/8)
980 line=yy and 7
990 pk=bm+row*320+8*col+line
1000 bit=7-(xx and 7)
1010 p=peek(pk) or (2↑bit)
1020 return
1232

ready.
```

The above program can be easily adapted, using different locations for the **POKEs**, for the VIC 20, although you will be tight for space if you try to do anything useful on an unexpanded VIC 20. Sprites, however, are only available on the 64 and as the manual does not give a routine for generating them, one is included here. The numbers to be used for POKEing into the sprite data area are listed on the printer at the end of the program.

```
10 rem sprite generator
100 rem ob is start poke loc of grid
110 rem cl is colour for pokes
120 rem v is start poke loc of video chip
130 rem yn is a flag. (fill/not fill space on grid
     )
140 rem sc is colour of screen,bd is colour of bor
     der
150 sc=53281:bd=53280:ob=1109:cl=55296-1024:print"
     ":poke sc,1
160 rem *** print top row of nos ***
170 print "     ";:for n=1 to 24:print right$(str$
     (n),1);:next:print
180 rem ***  print grid ***
190 for n=1 to 21:x$="":if n<10 then x$=" "
200 print "█";x$;n;"█ PPPPPPPPPPPPPPPPPPPPPPPP"
210 next
220 print"        ────────────────────────███"
230 :
240 :
250 rem ******************************
260 rem ***  key operations (move)  ***
270 rem ******************************
280 get ky$:if ky$="" then 280
290 bo=ob
300 if ky$="█" then ob=ob+40:goto 390:dn
310 if ky$="█" then ob=ob-40:goto 390:up
320 if ky$="█" then ob=ob+1:goto 390:rit
330 if ky$="█" then ob=ob-1:goto 390:lft
```

```
340 if ky$=" " or asc(ky$)=160 then n=1:if yn=1 th
     en n=0
350 yn=n
360 if ky$="e" then 480:rem *** ending
370 :
380 :
390 if peek(ob)<>80 and peek(ob)<>96+128 then ob=b
     o:rem ** check for off-grid
400 poke ob,80:poke ob+cl,5:poke ob,96+128:poke ob
     +cl,12:if yn=1 then 420
410 poke ob,80:poke ob+cl,5
420 goto 280
430 :
440 :
450 rem ********************************
460 rem ***   working out sprite      **
470 rem ********************************
480 poke sc,6:dim sp(65):rem move dim to start if
     modified to recycle this
490 for l1=1 to 21
500 for l2=1 to 3
510 no=1023+((l2-1)*8)+(l1*40)
520 for l3=1+no to 8+no
530 if peek(l3+45)=224 then m=m+2↑(8-(l3-no))
540 next l3
550 sp(ri)=m:ri=ri+1:m=0
560 next l2
570 next l1
580 :
590 rem ***    printout    ***
600 open 4,4:cmd4:print"█":for n=0 to 62:print sp(
     n);:next n:print#4
610 :
620 :
630 :
640 :
650 :
660 print"██"
670 v=53248:poke v+21,4:rem sprite 3
680 poke 2042,13:rem ** data loc
690 for n=0 to 62: poke 832+n,sp(n):next:rem *** p
     oke in data
700 y=100:x=y:poke v+41,1
710 get ky$:if ky$="" then 710
720 xx=x:yy=y
730 if ky$="█" then y=y+3:rem down
740 if ky$="█" then y=y-3:rem up
750 if ky$="█" then x=x+3:rem right
760 if ky$="█" then x=x-3:rem left
770 if x>255 or x<0 or y>255 or y<0 then x=xx:y=yy

780 poke v+4,x:rem **x loc of sprite 3
790 poke v+5,y:rem **y loc of sprite 3
800 goto 710

ready.
```

Finally, you may be interested in the little routine used to print these listings in 50 col format for convenience of printing in this book. First a listing must be made to the tape by loading any program say PROGRAM for which the listing is required, and typing in direct mode

OPEN 1,1,1,"LISTING"

...press play/record and wait for READY.

CMD1:LIST

...wait for the listing to finish, then

PRINT # 1 followed by CLOSE 1

Then load the program below, set up the printer and run.

```
10 open 1,1,0,"listing":open 4,4:ct=0
20 get#1,a$:if st<>0 then 50
25 ln$=ln$+a$
30 ct=ct+1:if a$=chr$(13)then ct=0:gosub 60
40 if ct=50 then ct=0:gosub 60:print#4:print#4,"
     ";
45 goto 20
50 print#4:close1:close4
55 end
60 print#4,ln$;:ln$=chr$(17):return

ready.
```

SECTION 4 Glossary of Common Terms

Addressing
The computer needs to talk to its memory and to various peripherals. Each memory location and peripheral has an address, usually unique, which the computer uses to get it to accept or send information. For non unique addresses, the computer must have only one item at a time responding or there will be trouble. It is therefore important to ensure that a cartridge is not fitted while extra RAM memory occupying the same address is switched in.

Algorithm
The method used for solving a problem. As the designer and programmer cannot solve the actual problems the computer will meet, all they can do is to provide it with the means or algorithm required to solve these problems.

Array
A set of variables held as a single list e.g. A(1),A(2)..... or as a multi dimensional array or matrix e.g. B$(1,1),B$(1,2).. when variables are related such as a set of cars which may be identified by serial numbers 1 to 2Ø. Then the drivers' names would be held as say NA$(N) where N is the car number. Two dimensional arrays are useful when comparing month-by-month expenses for the 2Ø cars when EX(15,3) could represent the expenses in March for car number 15.

ASCII
American Standard Code for Information Interchange. This is one of the standard conventions for converting characters to numbers as stored on a computer or sent along a communications link. The other main standard is **EBCDIC** which differs only slightly.

Assembler
An aid to writing programs in machine code. Instead of writing down the actual machine code entries as must be done in **POKE** statements, this allows the use of mnemonics such as LDA (load A register). Not covered by this book.

Base
Normal decimal numbers are to the base 1Ø. Other bases used are binary (2), octal (8) and hexadecimal (16). Binary digits can only be 1 or Ø, octal digits are between Ø and 7, and hexadecimal digits are between Ø and 15 (i.e. Ø,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F).

Whereas people are familiar with decimal, computers work in binary. Three binary digits can be dispayed as a number between Ø and 7 (octal) and 4 binary digits can be expressed as hexadecimal, so making these two particularly useful in writing down long strings of binary digits without making it difficult for the human observer to convert them back again, as each digit is individually converted to 3 or 4 binary digits. For example decimal 63 is binary 111111 or OCT 77 or HEX 3F.

BASIC
Beginners All-purpose Symbolic Instruction Code – the language supplied with almost all microcomputers, both business and home, the high level language described in this book. High level means that it does the work of converting your wishes from an English-like language to machine code and memory storage without troubling you with the details. COBOL, FORTRAN and RPG are also high level languages. Low level languages like Assembler require you to know a great deal

about how the processor and some other chips operate.

Binary
See **Base.**

Bit
An element of a computer. In almost all computers today this element can be in one of only two states represented by 1 and Ø i.e. as a binary digit.

Boolean Logic
The logic used in **AND OR NOT** statements (q.v.).

Buffer
An area of memory held for temporary storage before moving data around in larger chunks – usually for writing out to cassette, which requires 192 bytes, or to disk or printer. These buffers are handled by the computer and do not normally need any direct intervention by the programmer. They can be in the computer memory itself or in the peripherals.

Bug
An error, usually in software but sometimes used to refer to problems in the design of a chip or other hardware.

Byte
A contiguous set of bits, usually 8 (always 8 on these machines) in number, occupying one memory location. This width is sufficient to hold an **ASCII** character, converted to a number between Ø and 255, and this therefore often represents one character, e.g. 65 is **ASCII** code for 'A', 66 is **ASCII** code for 'B'.

Code
Any computer language statements. In this book code almost always means BASIC high level language code.

Compiler
A compiler scans the BASIC code before it is run and sets up the machine code ready for the run. The BASIC interpreter normally used (the one you get with the system) deals with every line as it reaches it whereas the compiler has scanned them all to produce more efficient code. Unfortunately a true high efficiency compiler does not to my knowledge exist at the time of writing, but there are intermediate compilers which can still improve speed performance by about a factor of 5, and save some space.

Default
This describes what will happen if you make no positive decision in a particular case. For instance, if you do not **DIM**ension an array before the program comes across it, its dimensions will default to 11.

Device
Any piece of hardware e.g. DEVICE NOT PRESENT as a message when addressing, say the printer, means that the computer is not getting the right response and therefore does not recognise it as present. See **Peripherals.**

Function
A mathematical formula that can be defined at the start of a program and then used as shorthand within the computer (see **FN**), or its ordinary English meaning as in 'the function of the keyboard is to allow data entry'.

Garbage
A term referring to the small pieces of memory left after string manipulation has altered lengths of strings and left spaces in between too small to be useful. Garbage collection takes place when the strings are shuffled about to create one large usable space. See **FRE.**

Hex
See **Base.**

I/O
The standard abbreviation for Input/output to or from the computer from its peripherals or other items in the outside world.

Input
Input is information coming into the computer from outside.

Interface
The contact between a computer and its peripherals or its contact with the outside world through the RS232 interface or the user ports. The RS232 interface is a standard hardware socket, but the VIC/CBM 64 only has 5 volt output and must be converted to 12 volt standard for compatibility with most other RS232 devices.

Keywords
Words having a specific meaning to BASIC such as **GOTO**. Using long BASIC variable names, there is always a chance that variables may be confused (by the Interpreter) with Keywords. TOTAL is confused with the keyword **TO** and will give a SYNTAX ERROR.

Kilobyte (k)
One thousand bytes, or to be exact 1Ø24 bytes of memory.

Logic
Logic is the structure on which we try to build our computer systems. The computer is a hard taskmaster and reveals the flaws in our logical powers! (see also **AND NOT OR** boolean logic)

Logical line
A logical line is up to 8Ø characters long. Because the screen cannot hold that number of characters, there can be more than one screen line per logical line. When entering BASIC lines these are only terminated by a <RETURN>. The screen lines have little significance to the program except when working on screen displays.

Machine code
The natural language of any computer, consisting, fundamentally, of a series of ON-OFF switches, represented by the binary numbers Ø and 1.

In an 8 bit computer, each machine code instruction is provided by a block of eight binary digits, which for convenience, we normally convert to either Hexadecimal or decimal numbers, as long strings of zeros and ones can be unwieldy and difficult to remember.

Short lengths of machine code can be created by **POKE**ing numbers into RAM locations. This can be done only for a few locations, without becoming thoroughly confused, and it is better to use an Assembler for any significant lengths of code. Remember that machine code does not insulate you from crashing the system, like BASIC does, so frequent **SAVE**s to disk of any BASIC using **POKE**s and **SYS** statements is desirable. It is essential to **SAVE** any machine code program before running it for the first time.

Nesting
Nesting is the very useful technique of placing loops inside each other in order to process arrays or other large structured data. **FOR ...NEXT** loops can be nested, as can subroutines (**GOSUB**). Examples abound in the main text (**FOR,GOSUB**) and in Section 3.

Octal
Not often used now – see **Base**.

Output
The transfer of information from the computer to its peripherals or the outside environment (e.g. network).

Peripherals
The devices attached to the computer to allow it to interact effectively with the outside world. Examples are monitor, printer, tape cassette unit and disk drive. See **Device**.

Port
A plug connection for peripherals. The user ports are plug connections for anything you care to connect. However as these ports connect directly to the works of the computer caution is advised!

RAM
Random Access Memory is memory on chips within the machine, the contents of which can be changed as required by the programmer or the interpreter.

Real
Means that the facility (e.g. memory) you are using is actually present on the machine. Not relevant to most micros – all the memory you can access by **POKE** and **PEEK** is really there – see **Virtual.**

Real numbers
Numbers expressed to one or more decimal places. The opposite of integers.

ROM
Read Only Memory is memory with a fixed pattern burnt into the chips which the computer can interpret as either data or programs. The BASIC interpreter is held in this way, and read into RAM on starting the CBM 64.

Software
Programs used to make the computer operate.

Statement
A statement is BASIC code terminated by a colon or a <RETURN>, whichever is sooner.

Structured Programs
These are built up of subroutines (or the equivalent in other languages) in a systematic and ordered manner. **GOTOs** are rare as each subroutine returns only to the subroutine that called it, or to the main program code which consists mainly of a series of **GOSUBs**.

Syntax
The structure or 'grammar' of a language, whether it is English, German or BASIC is known as the syntax. Bad BASIC syntax will produce a SYNTAX ERROR and no further progress will be possible until this is corrected. In other words, syntax is the rule book for the language.

Transparent
The facility you are using is not visible to you. Loading and use of the BASIC interpreter is transparent because it all happens without you having to know any more than the rules of the BASIC language. See also **Virtual.**

Variable
A variable is the name given by you to a location or locations in memory where information is held. BASIC decides where to put the variable and how much space to allow for it from the way you use it and from its name terminator if any (i.e. $ for strings and % for integers). For example if you say A=2 in your program, BASIC will check to see if A exists and if not will create a location for it. It will then put the value 2 in that location. If A already exists, the new value you are assigning to it will overwrite

(replace) any previous value.

Virtual
This term is used when your machine pretends it has facilities that it does not have. Some machines have only 64 kbytes of memory but if the user wants to use more than that, some of the 64k can be stored on disk and replaced by disk memory which is given addresses above 64k, so appearing to the user (you, that is) as if it had, say, 128k. Not a facility provided by CBM machines, but you can use it in your own programs to store part of a spreadsheet on disk if it's too large to go in memory.

Remember:
If you can see it and it's there, it's **real**
If you can see it but it's not there, it's **virtual**
If you can't see it but it's there, it's **transparent**
If you can't see it and it's not there, it's **gone!**

Appendix A – Control Characters used in the Programs

```
"■" - HOME
"■" - CLR
"■" - CURSOR DOWN
"■" - CURSOR UP
"■" - CURSOR RIGHT
"■" - CURSOR LEFT
"■" - REVERSE ON
"■" - REVERSE OFF
"■" - BLACK   - CTRL & 1
"■" - WHITE   - ETC
"■" - RED
"■" - CYAN
"■" - PURPLE
"■" - GREEN
"■" - BLUE
"■" - YELLOW
"■" - F1   -   FUNCTION KEYS
"■" - F2
"■" - F3
"■" - F4
"■" - F5
"■" - F6
"■" - F7
"■" - F8

READY.
```

```
control characters used in the programs

"■" - home
"■" - clr
"■" - cursor down
"■" - cursor up
"■" - cursor right
"■" - cursor left
"■" - reverse on
"■" - reverse off
"■" - black   - ctrl & 1
"■" - white   - etc
"■" - red
"■" - cyan
"■" - purple
"■" - green
"■" - blue
"■" - yellow
"■" - f1   -   function keys
"■" - f2
"■" - f3
"■" - f4
"■" - f5
"■" - f6
"■" - f7
"■" - f8

READY.
```

Appendix B – Characters Printed for ASCII Values

ASCII	UPPER	LOWER	ASCII	UPPER	LOWER	ASCII	UPPER	LOWER	ASCII	UPPER	LOWER
33	!	!	82	R	r	163	▔	▔	212	▏	T
34	"	"	83	S	s	164	▁	▁	213	╭	U
35	#	#	84	T	t	165	▏	▏	214	╳	V
36	$	$	85	U	u	166	▒	▒	215	○	W
37	%	%	86	V	v	167	▕	▕	216	♣	X
38	&	&	87	W	w	168	▒	▒	217	▕	Y
39	'	'	88	X	x	169	◤	▒	218	♦	Z
40	(	(	89	Y	y	170	▕	▕	219	┼	┼
41	)	)	90	Z	z	171	├	├	220	▒	▒
42	*	*	91	[	[	172	▗	▗	221	│	│
43	+	+	92	£	£	173	└	└	222	π	▒
44	,	,	93	]	]	174	┐	┐	223	◥	▒
45	-	-	94	↑	↑	175	▂	▂	224		
46	.	.	95	←	←	176	┌	┌	225	▌	▌
47	/	/	96	─	─	177	┴	┴	226	▄	▄
48	0	0	97	♠	A	178	┬	┬	227	▔	▔
49	1	1	98	│	B	179	┤	┤	228	▁	▁
50	2	2	99	─	C	180	▎	▎	229	▏	▏
51	3	3	100	─	D	181	▍	▍	230	▒	▒
52	4	4	101	─	E	182	▐	▐	231	▕	▕
53	5	5	102	─	F	183	▔	▔	232	▒	▒
54	6	6	103	│	G	184	▀	▀	233	◤	▒
55	7	7	104	│	H	185	▃	▃	234	▕	▕
56	8	8	105	╮	I	186	┘	✓	235	├	├
57	9	9	106	╰	J	187	▖	▖	236	▗	▗
58	:	:	107	╯	K	188	▝	▝	237	└	└
59	;	;	108	└	L	189	┘	┘	238	┐	┐
60	<	<	109	╲	M	190	▘	▘	239	▂	▂
61	=	=	110	╱	N	191	▚	▚	240	┌	┌
62	>	>	111	┌	O	192	─	─	241	┴	┴
63	?	?	112	┐	P	193	♠	A	242	┬	┬
64	@	@	113	●	Q	194	│	B	243	┤	┤
65	A	a	114	─	R	195	─	C	244	▎	▎
66	B	b	115	♥	S	196	─	D	245	▍	▍
67	C	c	116	▏	T	197	─	E	246	▐	▐
68	D	d	117	╭	U	198	─	F	247	▔	▔
69	E	e	118	╳	V	199	│	G	248	▀	▀
70	F	f	119	○	W	200	│	H	249	▃	▃
71	G	g	120	♣	X	201	╮	I	250	┘	✓
72	H	h	121	▕	Y	202	╰	J	251	▖	▖
73	I	i	122	♦	Z	203	╯	K	252	▝	▝
74	J	j	123	┼	┼	204	└	L	253	┘	┘
75	K	k	124	▒	▒	205	╲	M	254	▘	▘
76	L	l	125	│	│	206	╱	N	255	π	▒
77	M	m	126	π	▒	207	┌	O			
78	N	n	127	◥	▒	208	┐	P			
79	O	o				209	●	Q			
80	P	p	161	▌	▌	210	─	R			
81	Q	q	162	▄	▄	211	♥	S			

Appendix C Some Useful Memory Locations

HEX ADDRESS	DECIMAL LOCATION VIC 2Ø :	COMMODORE 64	DESCRIPTION
ØØØ1–ØØØ2	1–2		User jump to location (high byte – low byte)
ØØØ1		1	651Ø On-Chip 8-Bit I/O Register
ØØ13	19	19	Flag:**INPUT** Prompt. **POKE** 19,1 suppresses the ? but also affects PRINTing, so must be restored to Ø immediately afterwards
ØØ16	22	22	Pointer to temporary string stack –35 in here supresses line numbers in listings
ØØ26–ØØ2A	38–42	38–42	Floating Point Product Of Multiply
ØØ2B–ØØ2C	43–44	43–44	Pointer to start of BASIC program
ØØ2D–ØØ2E	45–46	45–46	Pointer to start of variables (following program)
ØØ2F–ØØ3Ø	47–48	47–48	Pointer to start of arrays (following variables)
ØØ31–ØØ32	49–5Ø	49–5Ø	Pointer to position after end of arrays
ØØ33–ØØ34	51–52	51–52	Pointer to bottom of string storage (moving down)
ØØ37–ØØ38	55–56	55–56	Highest address used by BASIC
ØØ39–ØØ3A	57–58	57–58	Current BASIC line number
ØØ3B–ØØ3C	59–6Ø	59–6Ø	Previous BASIC line number
ØØ3D–ØØ3E	61–62	61–62	Pointer to BASIC statement for **CONT**
ØØ3F–ØØ4Ø	63–64	63–64	Current **DATA** line number
ØØ41–ØØ42	65–66	65–66	Pointer to current **DATA** item
ØØ43–ØØ44	67–68	67–68	Vector for input routine
ØØ45–ØØ46	69–7Ø	69–7Ø	Current BASIC variable name pointer
ØØ47–ØØ48	71–72	71–72	Current BASIC variable data pointer
ØØ49–ØØ4A	73–74	73–74	Index variable pointer for **FOR/NEXT**
ØØ7A–ØØ7B	122–123	122–123	Pointer to current byte of BASIC text
ØØ8B–ØØ8F	139–143	139–143	Floating **RND** function Seed Value
ØØ9Ø	144	144	Status word **ST**
ØØ91	145	145	Flag:STOP key/RVS key
ØØ92	146	146	Timing constant for tape
ØØ98	152	152	Number of open files or pointer to file table
ØØ99	153	153	Default input device(Ø)
ØØ9A	154	154	Default output device(3)
ØØ9B	155	155	Tape character parity
ØØAØ–ØØA2	16Ø–162	16Ø–162	Clock
ØØB2–ØØB3	178–179	178–179	Pointer to start of tape buffer
ØØB8	184	184	Current logical file number
ØØB9	185	185	Current secondary address
ØØBA	186	186	Current device number
ØØBB–ØØBC	187–188	187–188	Current file name pointer

ØØC5	197	197	Current key pressed CHR$(n) Ø=No key
ØØC6	198	198	Number of characters in keyboard buffer
ØØC7	199	199	Inverse video on or off: Ø=Off :1=On
ØØC8	2ØØ	2ØØ	Pointer to end of logical line for **INPUT**
ØØC9–ØØCA	2Ø1–2Ø2	2Ø1–2Ø2	Cursor X–Y pos, start of INPUT
ØØCC	2Ø4	2Ø4	Cursor blink enable Ø = flash cursor
ØØCD	2Ø5	2Ø5	Timer:Count-down to toggle (switch on or off) cursor
ØØCE	2Ø6	2Ø6	Character under cursor
ØØCF	2Ø7	2Ø7	Flag:Last cursor blink On/ff
ØØDØ	2Ø8	2Ø8	Flag:**INPUT** or **GET** from key-board
ØØD1–ØØD2	2Ø9–21Ø	2Ø9–21Ø	Current screen address
ØØD3	211	211	Cursor position on line
ØØD4	212	212	Flag:Editor in quote mode OFF=Ø: ON=1
ØØD5	213	213	Length of screen line (physical)
ØØD6	214	214	Screen row where cursor is
ØØD8	216	216	Flag:Insert mode >Ø=INST
ØØF3–ØØF4	243–244	243–244	Pointer to current area of colour
Ø277–Ø28Ø	631–64Ø	631–64Ø	Keyboard buffer queue
Ø281–Ø282	641–642	641–642	Pointer to start of memory
Ø283–Ø284	643–644	643–644	Pointer to top of memory
Ø286	646	646	Current character colour in range Ø–15

Ø287	647	647	Background colour under cursor
Ø288	648	648	Top of screen memory (page no.)
Ø289	649	649	Size of keyboard buffer (queue length), normally 1Ø.
Ø28A	65Ø	65Ø	Flag:REPEAT key used $8Ø (dec 128) =repeat all
Ø28B	651	651	Repeat – speed counter
Ø28C	652	652	Repeat – delay counter
Ø28D	653	653	Bits Ø,1 and 2 are flags for keys SHIFT CBM CTRL e.g. 7 = all three keys depressed
Ø31Ø		784	USR function jump instruction
Ø311–Ø312		785–786	USR address low byte/high byte
Ø314	788–789	788–789	Clock interrupt
Ø33C–Ø3FB	828–1Ø19	828–1Ø19	Tape I/O buffer
Ø4ØØ–Ø7E7		1Ø24–2Ø23	byte screen memory area
Ø7F8–Ø7FF		2Ø4Ø–2Ø47	Sprite data pointers
Ø4ØØ–ØFFF	1Ø24–4Ø95		3K expansion RAM area
Ø8ØØ–9FFF		2Ø48–4Ø959	Normal BASIC program space
1ØØØ–11FF	4Ø96–46Ø7 (expanded)		Screen memory
ØØØ–CFFF		49152–53247	RAM 4Ø96 bytes
DØØØ–DFFF		53248–57343	Input/Output devices and colour RAM
1EØØ–1FFF	768Ø–8191 (unexpanded)		Screen memory
9ØØØ	36864		Horizontal position of screen – normally 12
9ØØ1	36865		Vertical position of screen –normally 38

9ØØ2	36866	Width of box – normally 15Ø
9ØØA–9ØØE	36874–36878	Sounds and volume

Appendix D Error Codes

BAD DATA indicates that string data has been received from a file where the program expected numbers, i.e. the program was reading the received information into numeric variables.

BAD SUBSCRIPToccurs when an array is being used and the subscript (or for a multi-dimensioned array, one of the subscripts) is out of the range specified in a **DIM** statement. If no **DIM** statement has been entered by the programmer, the subscript is assumed to be between Ø and 1Ø. For example 12Ø A (X)=25 will give a BAD SUBSCRIPT report if X is not within the **DIM**ensions set in the DIM A () statement at the time that line 12Ø above is executed.

BREAK is not really an error message. It occurs whenever the program was stopped by the <STOP> key or a **STOP** in the program. Variables can be altered before continuing.

CAN'T CONTINUE will be displayed if a **CONT** is typed when the program is unable to resume where it left off. This will occur for a syntax error because the statement cannot be understood and will also occur if the program has been edited, as it has then been rearranged in memory, and all variables cleared. If the program has stopped because of a syntax or similar error, it is possible to continue running the program by **GOTO** a valid line. This can be useful if the error has occurred in a line such as a **PRINT** statement which does not affect the logic of the program. **GOTO** the line logically following the error line will allow the program to continue while still retaining the values of all variables set. Variables can be altered at this point if desired, before resuming.

DEVICE NOT PRESENT usually appears if the device referred to is not present – exactly as the message says! You may have forgotten to plug it in or switch it on or initialise it, or you may have it on the wrong channel number. (Disk is usually 8 and printer 4, but they can be changed – see the manuals.) Sometimes after a read or write error while using disks the error will appear on trying to **SAVE** a program. This can be cleared without losing information by a **VERIFY**.

DIVISION BY ZERO. As you will remember from school this is not allowed in the real world.

EXTRA IGNORED. Too many items in response to an **INPUT**. This usually occurs because a comma has been unintentionally included in response to an input. The last item(s) entered are rejected.

FILE NOT FOUND means what it says – i.e. no file of this name on disk.

FILE NOT OPEN means that you have tried to use a file not yet opened. Check your program logic.

FILE OPEN. Once a file has been opened it cannot be opened again, nor can the same number be used to open any other file. Close it before trying to continue.

FORMULA TOO COMPLEX. You have to be pretty smart to get this one! Break it down into simpler expressions until both you and the computer can understand it.

ILLEGAL DIRECT occurs when using statements such as **INPUT** in direct mode. Such statements are only valid within a program.

ILLEGAL QUANTITY. A number is out of range. This can happen for a variety of reasons and is explained within the main body of the book in the places it can occur. It can also occur anywhere where an integer is > 32767 or < –32768 or in extreme circumstances where ordinary numerics are greater than about 1Ø to the power of 38 or less than 1Ø to the power –39 using the E notation. It is difficult to imagine what you would be doing to get either of these last two errors.

LOAD (ERROR) means a corrupt tape, dirty heads or perhaps an incorrect disk initialisation causing the disk directory (BAM) to become corrupt. Always give your disks different identifiers and ID numbers and then this problem should not occur.

NEXT WITHOUT FOR is usually obvious but watch out for nested loops where you have inadvertently used the same variable in two FOR statements.

NOT INPUT FILE. You told the computer it was an output file so you can't now go reading from it.

NOT OUTPUT FILE. No writing to an input file!

OUT OF DATA means your **DATA** is finished and you are trying to go on **READ**ing it without having first done a **RESTORE**. Have you missed out a **DATA** item?

OUT OF MEMORY. This can occur for two reasons.
(a) The RAM is full because you have written a large program or have put a large number of strings in memory during program execution. Check the memory with a **FRE** before running the program, and another **FRE** after the program has carried out a few manipulations. A clue to string problems is that the program will stop for a few moments to a few minutes while the poor thing rushes around memory tidying up strings to make room for more, a process known as garbage collection. The cure is to tidy up your program or data strings (keep some on file perhaps) or to expand your VIC, or to buy a compiler for your 64.

(b) There are too many nested **GOSUB**s or **FOR** loops. This is indicated by the fact that a **FRE** reveals plenty of memory. It is rare for this problem to occur, except as a result of a program error where incorrect logic has caused **FOR** loops or **GOSUB**s to be called repeatedly from within themselves. See **FOR** and **GOSUB**.

OVERFLOW means that a calculation gives a result which is too large for the numeric variable to handle i.e. greater than 1.7Ø141884E+38. Note that this error does not occur for integers which always give ILLEGAL QUANTITY as error.

REDIM'D ARRAY occurs when an array has been dimensioned twice or used (and thus dimensioned by the computer) before the **DIM** statement. Note that this means that DIM statements at the start of your program should not be included in any loop, but only executed once at the start of your program.

REDO FROM START means that letters instead of numbers have been typed in response to an **INPUT**. The problem can also occur because of the **INPUT** (q.v.) bug.

RETURN WITHOUT GOSUB means what is says. It usually arises because you have forgotten to include an **END** or **STOP** between the main program and the subroutines, or a **RETURN** is missing at the end of a previous subroutine. This allows the program to continue into the wrong area of code where it meets a **RETURN** without having been sent there.

STRING TOO LONG – only 255 characters maximum are allowed in a string.

SYNTAX indicates that the computer cannot understand the intention of the programmer in writing the BASIC line. Usually the problem is a missing comma or **THEN** or mis-spelt BASIC word. The machine actually does know a bit more than it tells you, as it may have got half way along a line before discovering a problem, but it only actually gives you the line number. There are two solutions to a SYNTAX ERROR that cannot be easily found. One is to get a programmers toolkit which has a facility to point to the position where the problem was found, and the other is to break down your statement line until the syntax problem has become apparent. Look particularly for peculiarities like BASIC keywords embedded in variable names if your names are longer than 2 characters.

TYPE MISMATCH appears when a numeric type is assigned to a string variable or vice versa. Note that this error does not appear for assignments of integers to numerics and vice versa. Truncation can occur in these circumstances (see Introduction).

UNDEF'D FUNCTION. User defined functions must be defined in a **DEF FN** statement before use.

UNDEF'D STATEMENT means that a **GOTO** or similar statement refers to a line number which does not exist in this program.

VERIFY occurs if the information read off the tape or disk is not the same as that present in the computer. Check that the tape heads are clean and that the drive/tape unit is away from possible sources of interference including the TV set. Then check that you are verifying the correct item and try the **SAVE** and **VERIFY** again.

THE commodore PROGRAMMER'S ROUTE MAP

COMMODORE BASIC FOR THE COMMODORE 64 AND VIC 20

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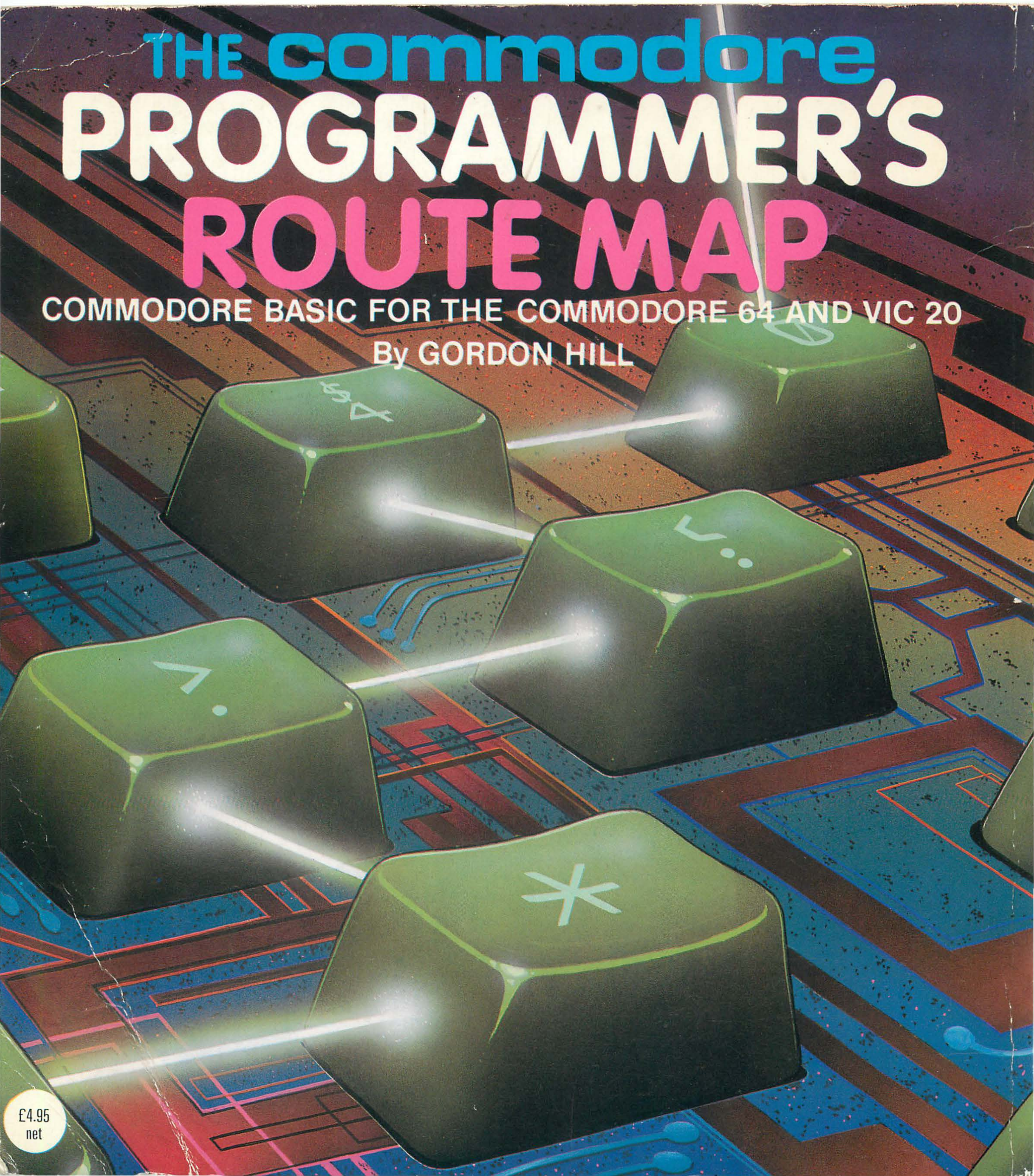

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