Computing

Software Development

[INTERMEDIATE 2]

David Bethune

(Adapted for True BASIC by Alan Patterson)

Learning
+Teaching
Scotland

Acknowledgements
Alan Patterson acknowledges that he has only changed the original work by David Bethune where it was necessary to convert any references to Visual Basic into the equivalent for True BASIC.
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Learning and Teaching Scotland gratefully acknowledge this contribution to the National Qualifications support programme for Computing.

First published 2004

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INTRODUCTION

Tutor guide

This teaching and learning material is designed to cover all the content needed by a learner to pass the Software Development unit of Intermediate 2 Computing. However, it is the responsibility of the tutor to check the content coverage against the SQA unit specification.

The pack covers the knowledge and understanding required for Outcome 1 assessment, and the practical skills required for Outcome 2. There are many opportunities throughout the unit (especially in Sections 3, 4 and 5) for students to demonstrate the practical skills required, and generate the required evidence.

For unit assessment, use should be made of the NAB assessment materials provided by SQA (multiple choice test and practical skills checklist).

Note that learners completing this unit as part of the Intermediate 2 Computing course should be given opportunities to develop the higher order problem solving skills required for the external course assessments (examination and practical coursework tasks). This can be done by providing past exam paper questions, and further programming tasks, such as the specimen coursework task provided by SQA.

The pack has not been designed for a student to use unsupported, although it might be possible to use it in this way. Students will need significant tutor support, particularly while attempting the practical programming sections of the unit. This support would include giving help with the complexities of the True BASIC environment, providing extra example programs where a student needs reinforcement activities, and emphasising key teaching and learning points as they occur.

All the examples provided are exemplified in True BASIC Silver Edition on a PC. Minor amendments might be required to run the programs in other versions, either earlier or later versions or the Apple Mac versions. This software development environment and programming language has been chosen, as it is one in common use in Scottish schools at present. However, the SQA unit specification does not require any particular language or environment, so the examples could be adapted and/or substituted by examples in any other structured procedural high level language. To facilitate this, the examples avoid where possible constructions that are very specific to True BASIC, and that are not easily converted into other languages.

Answers to questions are provided at the end of the pack, but not answers to programming tasks, as many possible correct answers are possible, and syntax may vary depending on the version of True BASIC in use.

Student guide

This teaching and learning material is designed to cover all the skills, knowledge and understanding that you need to pass the Software Development unit of Intermediate 2 Computing.

To achieve this unit, you must develop and demonstrate knowledge and understanding of:

- the principles of software development (Section 1)
- software development languages and environments (Section 2)
- high level language constructs (Sections 3 and 4)
- standard algorithms (Section 5).

At the end of the unit, you will be tested on this by sitting a short 20-question multiple choice test.

However, it is not only about passing a test. You must also develop practical skills in software development using a suitable high level language. Almost any programming language can be used, but these notes (especially Sections 3 to 5) assume that you are using True BASIC. If you are using a different programming language, your tutor will need to supply you with other materials for some parts of the unit.

Your tutor will complete a practical skills checklist for you as you work through the practical exercises in these notes. You should keep a folio of evidence; this should include documentation of all the stages of the software development process.

You will see the following icons throughout these notes.

Computer-based practical task – you will need access to a computer with True BASIC installed for this task.

??? **Questions for you to answer** – you can check your own answers against the sample answers given at the end of this pack.

Activity (non-computer-based) – this will usually require some written work.

You should ask your tutor to check your work whenever you complete a computer-based practical task or a non-computer-based activity.

SECTION 1

1.1 Software

This unit is about **software**.

What **is** software?

You should already know that any computer system is made up of **hardware** and **software**.

The term **hardware** is fairly easy to understand, because you can see it. It is all the pieces of equipment that make up the system – the processor, monitor, keyboard, mouse, printer, scanner and so on.

Software is not so obvious. It is all the programs, instructions and data that allow the hardware to do something useful and interesting.

Think about all the different items of **software** that you have used in the last week or so.

Here is the list of programs that I have used recently.

- **Microsoft Word** (the word processing program that I use – I regularly use three versions of it: Word 2000, Word 98 for MacOS 8, Word v.X for MacOS X)
- **Microsoft Excel** (spreadsheet used to keep charity accounts for which I am the treasurer)
- **ClarisWorks 4** (integrated package – I mainly use its word processor and simple database sections)
- **Internet Explorer** (both PC and Mac versions – for browsing the web)
- **Safari** (web browser for MacOS X)
- three different e-mail clients (**Netscape Communicator**, **MS Outlook** and **Mail**)
- **iPhoto** (for organising my digital photographs)
- **iMovie** (for editing digital movies)
- **Adobe Photoshop** (for editing digital photographs)
- **Citrix ICA** thin client (allows me to connect to my work computer from home)
- **Toast** (for burning CDs)
- **Print to PDF** (a shareware program for creating PDF files)
- **Adobe Acrobat** and **Preview** (for viewing PDF files)
- **Macromedia Flash** (for developing animated graphics)
- **Home Page** (an ancient but reliable web page editor)
- some **game** programs
- **Symantec Anti-virus** suite.

But that's not all! On each computer that I have used, a program (or group of programs) called the **operating system** must have been running. So I must add the following to my list.

- **Windows 97** (on the ancient laptop I am using to type these notes)
- **Windows XP** (on another laptop)
- **Windows 2000** (on a computer at school)
- **MacOS 8.1** (on my trusty old Mac clone)
- **MacOS X.2** (on my iMac).

Thirdly, a full list would include all the actual **documents**, **files**, **web pages**, **e-mails** and so on, that I had accessed, as these are also software. That would be too long a list, so I'll ignore

it here.
Activity

How about you? Make a list of all the software (programs and operating systems) that you have used over the last few days.

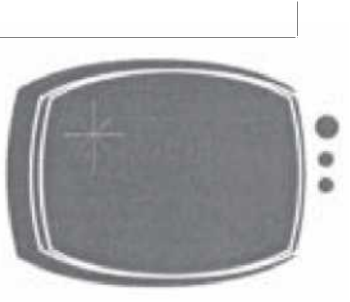
The point about all these is this: they didn't grow on trees! They are available for us to use because they have been designed and created by teams of software developers. In this unit, we are going to learn about the process of developing software, and to apply this process to develop some (simple) programs of our own.

Questions

1. What is the meaning of the term **hardware**?
2. Give three examples of **software**.
3. Identify each of the following as either hardware or software.

Item	**hardware**	**software**
monitor		
database		
Windows 97		
scanner		
an e-mail		
Internet Explorer		
mouse		
modem		
a computer game		
a word processor		
digital camera		

1.2 The development process



Before we think about how software is developed, it is worth considering how any product is developed, because the process is essentially the same. For example, think about the process of developing a new model of TV.

Stage 1: Analysis

Before a new product is developed, someone within the company, probably in the marketing department, analyses what people want. They consider which products are selling well, look at what rival companies are producing, and maybe even carry out a survey to find out what people want. From this they can work out which features are required in their newest model, including its size, target price range and various technical requirements.

They use this information to produce a **specification** for the new model of TV. This states clearly all the features that it must have.

Stage 2: Design

The next stage is to turn the specification into a design. Designers will get to work, alone or in groups, to design various aspects of the new TV. What will it look like? How will the controls be laid out? Sketches will be drawn up and checked against the specification. Another team of designers will be planning the internal circuitry, making sure it will allow the TV to do all the things set out in the specification.

Stage 3: Implementation

Once the design phase is over, engineers will get to work to actually build a prototype. Some will build the case according to the design, while others will develop the electronics to go inside. Each part will be tested on its own, then the whole thing will be assembled into a (hopefully) working TV set.

Stage 4: Testing

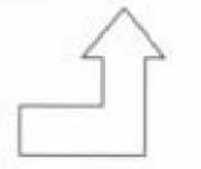
Before the new model can be put on sale, it will be thoroughly tested. A wide range of tests will be carried out.

It might be tested under '**normal**' conditions. It could be put in a room at normal room temperature, and checked to see that all the controls work correctly, the display is clear, it is nice and stable and so on.

If it passes this type of testing, it might next be tested under '**extreme**' conditions. For example, does it still work if the temperature is below freezing, or very hot and humid, if it used for long periods of time, or with the volume or the brightness or contrast set to their maximum values?

Finally, it could be tested under '**exceptional**' conditions. What happens if a 2-year old picks up the remote and presses all the buttons at once? What happens if there is a power cut, or a power surge?

If it fails any of these tests, it might be necessary to go back to the implementation (or even design) stage and do some further work, before re-testing.



If it passes all the tests, then the new TV can go into production.

Stage 5: Documentation

However, the development isn't yet complete! Some documentation will be needed to go with the TV – a **User Manual** containing all the instructions about how to work the new TV, and probably a **Technical Manual** for repair engineers.

Stage 6: Evaluation

Once the model is in production, the company will want to evaluate it. Does it do what it is supposed to do? Is it easy to use? And, from the engineer's point of view, is it easy to repair?

Stage 7: Maintenance

Stage 6 should be the end of the story, but in the real world, there needs to be stage 7 – maintenance. There are different kinds of maintenance: fixing faults that turn up once it is being used regularly, improving the design to make it even better, or making changes for other situations (like making a version that will work in another country).

These seven stages are an essential part of the production process.

Activity

OK, let's see if you have got the idea …

Choose any type of manufactured object – it could be a car, an item of clothing, a readymade meal, a toy, a piece of furniture, a building or ….

Now copy and complete this table, writing one sentence to describe each of the seven stages in the production of your chosen object.

Object chosen:_______________________________________

Stage	**Description**
1. Analysis	
2. Design	
3. Implementation	
4. Testing	
5. Documentation	
6. Evaluation	
7. Maintenance	

1.3 A dance in the dark every Monday

Exactly the same process goes into the production of a piece of software. The software engineers and their colleagues carry out all the stages of the software development process in order – analysis, design, implementation, testing, documentation, evaluation, maintenance.

Activity

Consider the production of a new game program by a software company.

Here are descriptions of the seven stages, but they are in the wrong order.

Copy and complete another table like the one below, and slot the stages into the correct places:

A. Writing a user guide and technical guide for the software.

B. Deciding what type of game you want to create, and what features you want it to have.

C. Adapting the game to run on a different type of computer.

D. Actually writing all the program code.

E. Checking that the program does what it is supposed to do, is easy to use, and can be fixed if there is a problem.

F. Working out the details of what the screens will look like, what menus and functions there will be, and other detailed aspects of the program.

G. Getting users to try out the program to make sure it works under most conditions.

Stage	Description
1. Analysis	
2. Design	
3. Implementation	
4. Testing	
5. Documentation	
6. Evaluation	
7. Maintenance	

Check your answers on the next page.

You should have the following.

Stage	Description
1. Analysis	B. Deciding what type of game you want to create, and what features you want it to have.
2. Design	F. Working out the details of what the screens will look like, what menus and functions there will be, and other detailed aspects of the program.
3. Implementation	D. Actually writing all the program code.
4. Testing	G. Getting users to try out the program to make sure it works under most conditions.
5. Documentation	A. Writing a user guide and technical guide for the software.
6. Evaluation	E. Checking that the program does what it is supposed to do, is easy to use, and can be fixed if there is a problem.
7. Maintenance	C. Adapting the game to run on a different type of computer.

In this course, especially from Section 3 onward, you will be putting this **software development process** into practice when you produce some simple programs in a high level computer programming language.

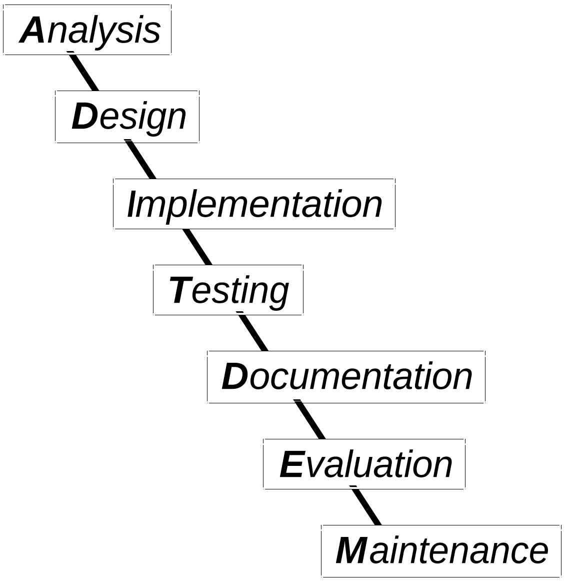
For the moment, it is worth trying to learn the steps in the correct order. I usually use a silly mnemonic for this:

A Dance In The Dark Every Monday

… which helps me remember ADITDEM:
Analysis
Design
Implementation
Testing
Documentation
Evaluation
Maintenance.

You might be able to make up a better mnemonic than this one – so long as it helps **you**, then it's OK!

Next, we will take a closer look at each of the stages.



1.4 Analysis

The main purpose of the analysis stage is to be absolutely clear about what the program is supposed to do. Often, a new program will start from a rough idea. Before getting started, it is important to turn the rough idea into an exact description of how the program will behave. What will it do? What are the inputs and the outputs? What type of computer is it to run on? All these questions, and many more, must be asked and answered at this stage.

The result of this is the production of a **program specification**, agreed by both the **customer** (whoever wants the program written) and the **developer** (the person or company who are developing the program).

1.5 Design

Inexperienced programmers are often tempted to jump straight from the program specification to coding, but this is not a good idea. It is worth spending time at the design stage working out some of the important details, including how the program will look on the screen, how the user will interact with the program, and how the program might be structured. Program designers use a variety of methods for describing the program structure. Two common ones are called **pseudocode** and **structure diagrams**. There are many others, but we will only consider these two.

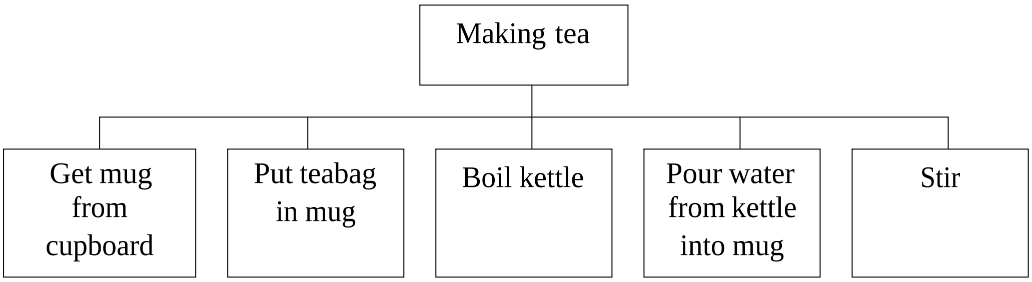
It is easy to understand these if we think about an everyday example, rather than a computer program.

Think about making tea. Here is a list of instructions for this task.

1. Get a mug out of the cupboard.
2. Put a teabag in it.
3. Boil the kettle.
4. Pour boiling water from the kettle into the mug.
5. Stir.

This is an example of **pseudocode**. It is a numbered list of instructions written in normal human language (in this case, English). It doesn’t go into all the details, but it gives the main steps.

Another way of showing this is as a **structure diagram**. It could look like this:



Each instruction goes into a separate box. You read **pseudocode** from top to bottom. You read a **structure diagram** from left to right.

Activity

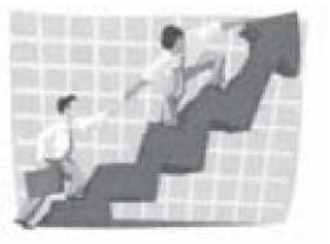
Now try a couple for yourself. Here are some simple tasks.

Going to school

Going to New York

Having a shower

Phoning a friend



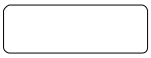
Becoming a millionaire

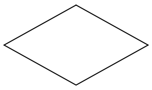
Choose any **two**, and write a pseudocode instruction and draw a structure diagram for each one.

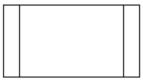
Don't make it too complicated. In the tea example, I broke making tea down into five steps. You could have broken it down into many more detailed steps. For example, getting a mug out of the cupboard could be broken down into smaller steps – walk across to the cupboard, open the door, choose a mug, lift it out, close the door, walk back across the room. Try to break the task down into between four and eight steps.

We will use pseudocode in Section 3 when we start to develop our own computer programs.

There are other graphical methods of representing the structure of a program. These include structure charts and flowcharts. Some use a variety of 'boxes' to represent different types of instruction. For example, you might see:

 to represent a **repeated action**

 to represent a **choice**

 to represent a step which will be **broken down into smaller steps**.

1.6 Implementation

In software development, implementation is the process of converting a program design into a suitable programming language.

There are thousands of different programming languages out there, all with their own advantages and disadvantages. For the purposes of this course, you only need to know about two main groups: **machine code** and **high level languages**. You will learn more about these in Section 2.

1.7 Testing

We looked at testing at the start of this section. Whether we are talking about a new TV, a new item of clothing, or a new computer program, the manufacturers will spend a great deal of time on testing. This will be carefully planned to test a wide range of conditions. We can divide it up into three types of testing.

- **Testing normal conditions**
  Making sure the program does what it should do when used 'normally'.

- **Testing extreme conditions**
  Making sure the program can handle situations that are at the edge of what would be considered normal.

- **Testing exceptional conditions**
  Making sure it can handle situations or inputs that it has not been designed to cope with.

You will see examples of all of these in Section 3.

1.8 Documentation

When you buy a product, whether it is a computer program or anything else, you usually get some kind of **User Guide** with it. This tells you how to use the product. It might also contain a tutorial, taking you through the use of the product step by step.

Some software comes with a big fat book called User Guide or Manual; others come with the User Guide on a CD.

As well as documentation for the user of the software, there should also be a **Technical Guide** of some sort. This gives technical information which is of little interest to most users, except that it will usually include information about the specification of computer required, including how much RAM it needs, how fast a processor it must have, and which operating system is required. The Technical Guide should also include instructions on how to install the software.

Activity

Get hold of a software package that has been bought by your school or college, or one you have bought yourself at home, open it up and take a look inside the box that it came in. Make a list of all the items of documentation that you find there.

1.9 Evaluation

The final stage in the process before the software can be distributed or sold is evaluation. Evaluation involves reviewing the software under various headings to see if it is of the quality required.

In this course, we will review software under three headings: **fitness for purpose**, **user interface** and **readability**.

Is the software **fit for purpose**? The answer is 'yes' if the software does all the things that it is supposed to do, under all reasonable conditions. This means going back to the program specification (produced at the analysis stage) and checking that all the features of the software have been implemented. It also means considering the results of testing, and making sure that the program works correctly and is free from bugs.

The **user interface** should also be evaluated. Is the program easy to use? Is it clear what all the menus, commands and options are supposed to do? Could it be improved in any way?

The third aspect of evaluation that we will consider is **readability**. This is of no direct concern to the **user** of the software, but is important for any **programmer** who may need to understand how the program works.

It is to do with the way that the coding has been implemented. Is it possible for the program code to be read and understood by another programmer, perhaps at a later date when the program is being updated in some way? We will look in Section 3 at some techniques for improving the readability of a program.

1.10 Maintenance

This final phase happens **after** the program has been put into use. There are different types of maintenance that might be required. These are called corrective maintenance, perfective maintenance and adaptive maintenance. You don't need to know these names until Higher level, but it is useful to think about what they mean.

Corrective maintenance means fixing any bugs that appear once the program is in use. Of course, these should all have been discovered during testing. However, most programs (but not the ones you will be writing) are so huge and complex that some bugs are bound to slip through unnoticed. If the bugs are serious in nature, the software company might issue a free 'patch' on its website, so that users can download the patch, and install it with the software, so fixing the bug. If it is a minor bug, they may not bother.

Perfective maintenance is adding new features to the software. These might be suggested as a result of the evaluation stage, or they might be suggested by users. These new features will then be added to the software, and re-issued as a new version. That's why software often has version numbers. Each version results from corrective and perfective maintenance of the earlier versions. So (for example), BloggProg 3.2 will be similar to BloggProg 3.1, but with bugs fixed, and some new features added.

The third type of maintenance is **adaptive maintenance**. This is where the software has to be changed to take account of new conditions. The most obvious example is when a new operating system comes out. Perhaps BloggProg 3.2 was designed to run under Windows 2000. When Windows XP came along, changes had to be made to BloggProg so that it would work under the new operating system.

Questions

1. Match up these descriptions of the stages of the software development process with the correct names (one has been done for you).

Stage	Description
Evaluation	Writing a user guide and technical guide for the software.
Testing	Working out the details of what the screens will look like, what menus and functions there will be, and other detailed aspects of the program.
Implementation	Deciding what type of game you want to create, and what features you want it to have.
Design	Actually writing all the program code.
Documentation	Adapting the game to run on a different type of computer.
Analysis	Checking that the program does what it is supposed to do, is easy to use, and can be fixed if there is a problem.
Maintenance	Getting users to try out the program to make sure it works under most conditions.

2. What three criteria will be used for evaluating software in this unit?
3. What is the relationship between pseudocode and a structure diagram?
4. Name two items of documentation usually provided with a software package, and describe what you would expect each one to contain.
5. What three types of testing should be applied to any software?
6. Describe two examples of maintenance that could be required on a game program.

SECTION 2

2.1 Computer languages

Just as there are many human languages, there are many computer programming languages that can be used to develop software. Some are named after people, such **Ada** and **Pascal**. Some are abbreviations, such as **PL/1** and **Prolog**. All have different strengths and weaknesses. **FORTRAN** was designed for carrying out mathematical and scientific calculations. **Prolog** is good for developing programs in artificial intelligence. **COBOL** is for developing commercial data processing programs.

Activity: Make a list of six or so programming languages (you can find these in textbooks or on websites). For each one, write down where it gets its name from, and what it is 'good' for.

Here are some examples to get you started:

Name	**Source of name**	**Used for**
Ada	after Countess Lovelace	US military systems
Logo	Greek for 'thought'	education
FORTRAN	FORmula TRANslation	early scientific language

All these languages are what we call **high level languages**. That is to distinguish them from **low level languages**! What do we mean?

2.2 High and low level languages

Inside every computer, there is a processor. This is a chip containing digital electronic circuits. These circuits work with tiny pulses of electricity and electronic components. The pulses of electricity can be represented by the digits 1 and 0. Every item of data and every instruction for the processor is represented by a group of these binary digits.

Processors only 'understand' these binary digits. The only inputs you can make to a processor are groups of binary digits. The only output that a processor can make is a group of binary digits.

Instructions and commands made for processors in this binary digital form are known as **machine codes**.

Here are a few machine codes for a 6502 processor:

```
10101001 00000001
10000101 01110000
10100101 01110000
```

I'm sure you'll agree that they are not very easy to understand.

There are several problems with machine code:

- machine codes for different processors are different
- they are very hard for humans to understand and use
- they take up a lot of space to write down
- it is difficult to spot errors in the codes.

Unfortunately, processors don’t understand anything else, so machine code has to be used. The earliest computers could only be programmed by entering these machine codes directly. It was a slow process, easy to get wrong, and it was very difficult to track down and fix any bugs in the programs. Machine codes are an example of **low level languages**, understood by the low level components of the computer system (the processor and other electronic circuits).

To get round these difficulties, computer scientists invented **high level languages**.

High level languages are similar to human languages. Instead of using binary codes, they use ‘normal’ words. For example, the computer language BASIC uses words like PRINT, IF, THEN, REPEAT, END, FOR, NEXT, INPUT and so on. That means that high level languages are easier to understand than machine code, and are more ‘readable’, that is, it is easier to spot and correct errors.

On the next page is a simple program written in a number of high and low level languages.

```
10 Number:= 1
20 Answer:= Number + 1
30 PRINT Answer
40 END
```

```
make ‘number 1
make ‘answer ‘number + 1
say ‘answer
```

```
PROGRAM adder;
VAR answer,number: real;
BEGIN
Number:=1;
Answer:=number+1;
WRITELN(answer);
END.
```

The first three are all examples of high level languages (BASIC, Logo and Pascal). All use words that are understandable to humans.

This is a low level language called 6502 assembler – not so easy to understand!

```
LDA #1
STA 1000
LDA 1000
ADC
STA 1001
JSR OSWRCH
RTS
```

```
10101001 00000001
10000101 01110000
10100101 01110000
01101001 00000001
10000101 01110001
00100000 11101110
11111111 01100000
```

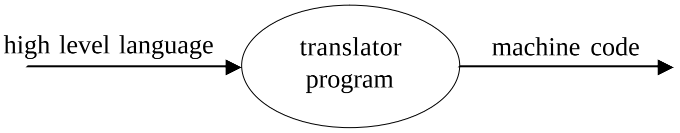
And this final one is 6502 machine code, which is completely unintelligible to (most) humans.

In fact, all five of these programs do more or less the same job! I think you will agree that high level languages are much more practical for writing programs than machine code!

Questions

1. Which type of language (high or low level) is easier to understand?
2. Which type would be easier to correct if it had a mistake in it?
3. Name two low level languages.
4. Name two high level languages.
5. Explain the main differences between high and low level languages.
6. List two advantages of high level languages.

It looks as though high level languages have all the advantages compared to machine code. However, there is one major problem – processors don’t understand high level languages at all! To get round this problem, computer scientists have developed translator programs which can translate high level languages (written by humans) into machine code (understood by processors).



2.3 Translators

There are two main types of translator program that you need to know something about. These are called **interpreters** and **compilers**.

To understand the difference, it is useful to think about an analogy from the 'non-computer' world.

Imagine that you are the world expert in some obscure subject, like 'the anatomy of the microscopic tube worms of the steppes of Kazakhstan'. You have been invited to present a lecture on this subject at a conference to be held in Japan. Most of the delegates at the conference do not speak or understand English, and you do not know any Japanese. How are you going to communicate?

There are two options.

2.4 Interpreters

Option 1 is to go to the conference yourself, and deliver your speech in English one sentence at a time. After each sentence, a professional translator (who can understand English and also speaks fluent Japanese) will turn your sentence in Japanese. This will continue right through your lecture, with the interpreter translating each sentence as you go along.

Computer interpreter programs work in the same way. The interpreter takes each line of high level language code, translates it into machine code, and passes it to the processor to carry out that instruction. It works its way through the high level language program **one line at a time** in this way.

This works fine, but it has a couple of important disadvantages. Think about the analogy again. Your one-hour lecture will take two hours to deliver, as each sentence is spoken by you in English, then by the interpreter in Japanese. The other disadvantage is that if you are then asked to deliver your lecture again in another Japanese city, you will need to have it translated all over again as you are delivering it the second time.

The same problem is true of computer interpreters. The process of translating the high level language (HLL) program slows down the running of the program. Secondly, the HLL program needs to be translated **every** time it is used. This is a waste of computer resources and means that the user must always have an interpreter as well as the HLL program (often called source code).

2.5 Compilers

An alternative approach is to use a compiler.

Going back to the Japanese lecture example – instead of using a translator at the conference, you could write down the text of your lecture in English, and get a translator to translate it all into Japanese in advance. You could then send the translated lecture script to the conference, and have it read out by a Japanese speaker there.

The advantages are obvious – your lecture can be delivered in the one hour allowed in the conference programme, and it can be used as often as required without it needing to be translated over and over again.

A compiler program works in the same way. It takes your HLL program, and translates the **whole** program into machine code once. This machine code can then be saved and kept. Once translated, it can be used over and over again without needing to be translated every time. The compiled program therefore runs more quickly, and the user doesn’t need to have a translator program on their own computer.

Software that you buy, such as a games program or an application, will have been **compiled** into machine code before being distributed and sold. What you get on the disk or CD is a machine code program that can run on your computer without needing to be translated.

Questions

1. Name the two main types of translator program.
2. Which one translates a whole program into machine code before it is executed?
3. Which one translates a program line by line as it is being executed?
4. Why do machine code programs run more quickly on a computer than high level language programs?

2.6 Text editors

During the development of a high level language program, after the analysis and design stages, the programmer (or team of programmers) has to **implement** the design by coding it in a suitable high level language.

Here is an example of a Visual BASIC program.

```
Private Sub cmdOK_Click()
  ‘ coding for the OK command button
  ‘ displays an appropriate message for each possible number entered
  ‘ written by A. Programmer on 29/12/03

  Dim Number as Integer

  Number = txtNumber.text

  If Number = 1 Then MsgBox Number & “ wins you a colour TV”
  If Number = 2 Then MsgBox Number & “ wins you a mobile phone”
  If Number = 3 Then MsgBox Number & “ wins you a holiday in Spain”
  If Number = 4 Then MsgBox Number & “ wins you 10p”
  If Number = 5 Then MsgBox Number & “ wins you a day at the beach”
  If Number < 1 Then MsgBox Number & “ is too small”
  If Number > 5 Then MsgBox Number & “ is too large”
End Sub
```

You can see that a high level language has features that make it similar to a human language – the use of ordinary words, for example. This means that the implementation is often carried out using similar tools to those used for writing an essay or report. For example, cut and paste would be useful when typing the program shown above. To write an essay or report, you would normally use a word processing package. High level language programs can also be written using a word processing package. The **source code** can be saved as a text file, which can then be translated into machine code by a compiler.

However, some software development environments provide a **text editor** which incorporates many of the usual features of a word processor. The most useful of these is probably the ability to cut and paste sections of code.

Activity: Consider the software development environment you are using for the programming section of this unit.

Does it have a text editor, or do you use a separate word processing package? What useful text editing features does it incorporate?

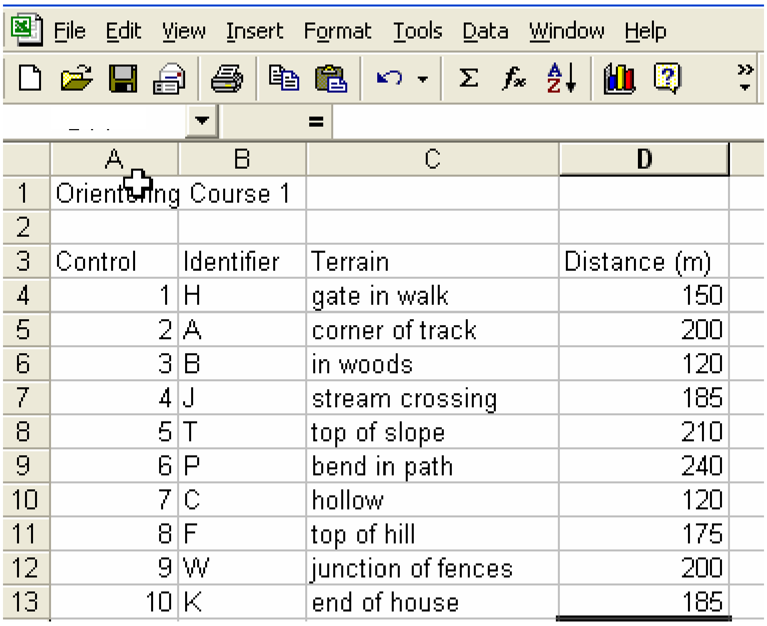
2.7 Scripting language and macros

Most of this unit is concerned with the process of developing programs written in a high level language to create stand-alone applications.

However, small programs called macros can be developed within some existing application packages.

Example 1: creating an Excel spreadsheet macro

Set up a small spreadsheet like this:



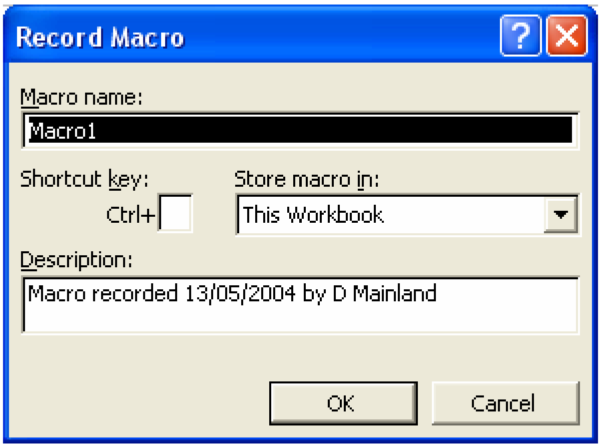
	A	B	C	D
1	Orienteering Course 1			
2				
3	Control	Identifier	Terrain	Distance (m)
4	1	H	gate in walk	150
5	2	A	corner of track	200
6	3	B	in woods	120
7	4	J	stream crossing	185
8	5	T	top of slope	210
9	6	P	bend in path	240
10	7	C	hollow	120
11	8	F	top of hill	175
12	9	W	junction of fences	200
13	10	K	end of house	185

Save it as **course.xls**

Save a second copy of the same spreadsheet as **course_copy.xls**

From the **Tools** menu, select **Macro**, then **Record New Macro**.

The following dialogue box should appear (*Note: date and name after 'Macro recorded' will be different*):



Macro name: Macro1

Shortcut key: Ctrl+

Store macro in: This Workbook

Description: Macro recorded 13/05/2004 by D Mainland

Enter the name (**tidy_up_SS**)

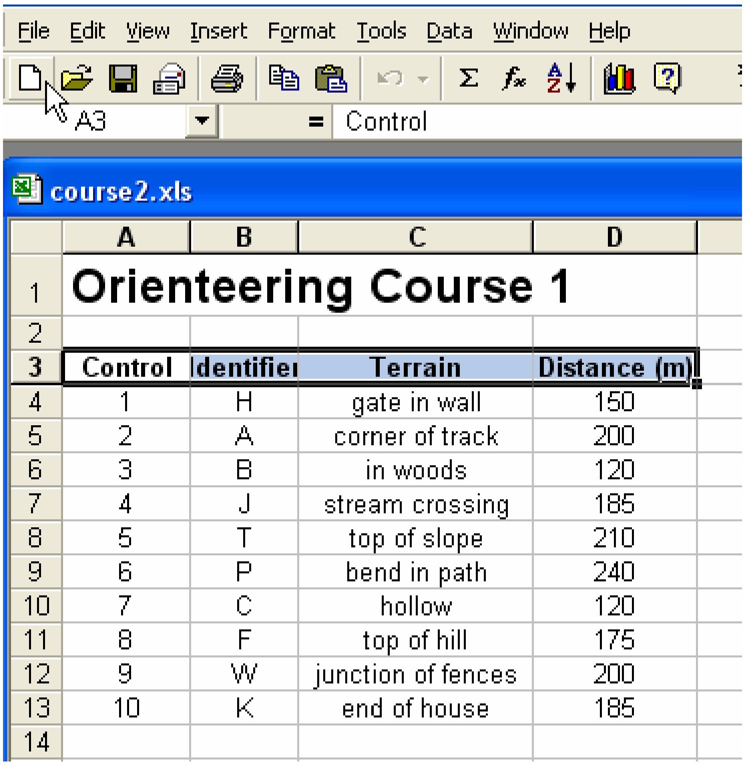
And the shortcut key (**Ctrl + Shift + K**)

Then click **OK**

Warning: follow these instructions very carefully – all your actions are being recorded!

- Select cell A1 (the title of the spreadsheet)
- Change its font to 18pt Bold
- Select A3 to D13 (all the data)
- Centre it all using the centre button on the menu bar
- Select row 3 (the column headings)
- Make them bold.

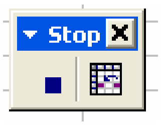
The spreadsheet should now look like this:



A3 = Control

	A	B	C	D
1	Orienteering Course 1			
2				
3	Control	Identifier	Terrain	Distance (m)
4	1	H	gate in wall	150
5	2	A	corner of track	200
6	3	B	in woods	120
7	4	J	stream crossing	185
8	5	T	top of slope	210
9	6	P	bend in path	240
10	7	C	hollow	120
11	8	F	top of hill	175
12	9	W	junction of fences	200
13	10	K	end of house	185
14				

Click on **Stop Recording**



Save the improved spreadsheet as **course2.xls**

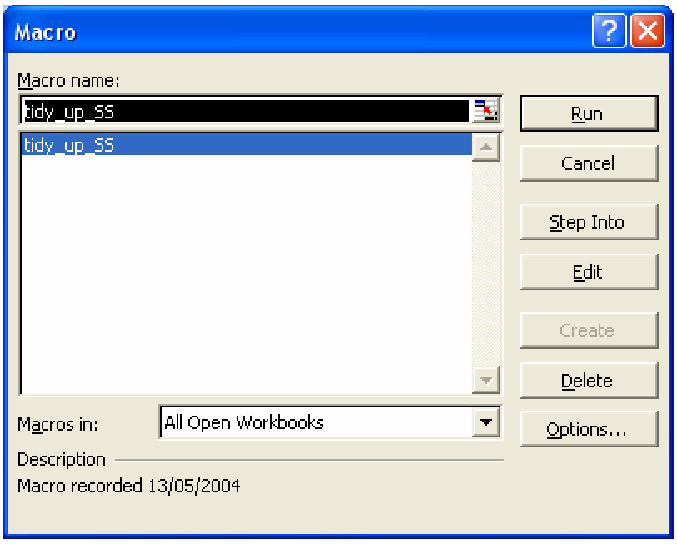
All the series of actions that you applied to **course.xls** to turn it into **course2.xls** have been recorded and stored as a **macro**.

To see the macro you have created:

- go to the Tools menu
- select Macro
- select Macros.

A dialogue box like this should appear, with your named macro listed under the name you gave it.

Click on **Edit**.



Macro name: tidy_up_SS

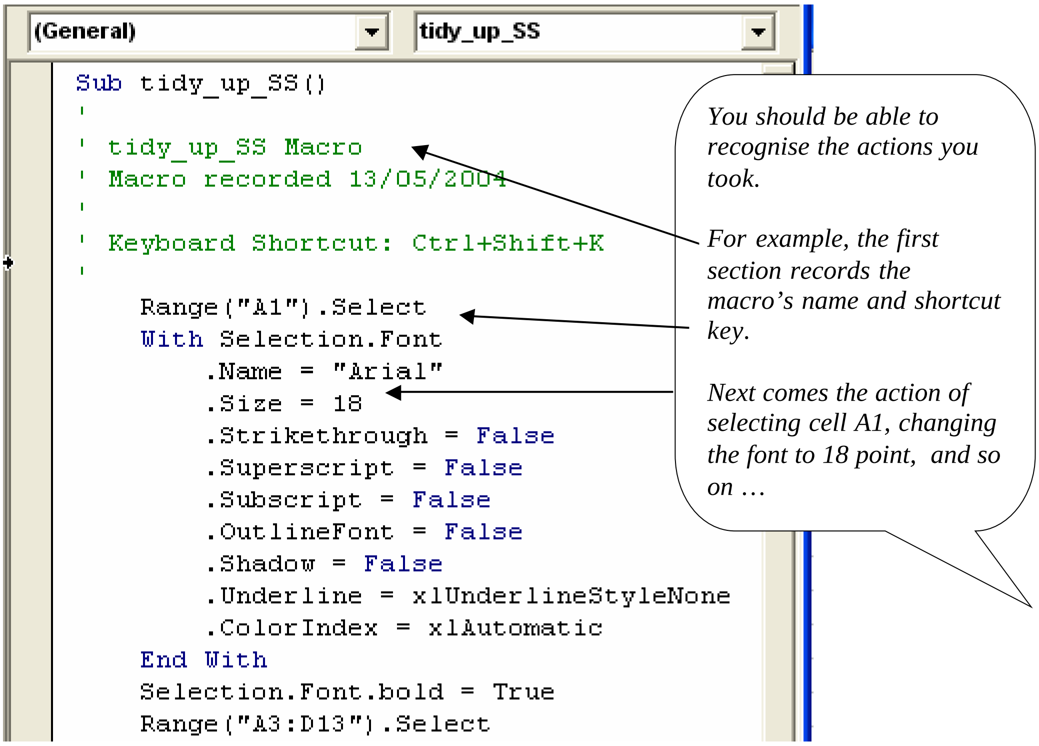
tidy_up_SS

Macros in: All Open Workbooks

Description

Macro recorded 13/05/2004

Another window will open, which displays the code of the macro you have recorded, like this.



```
Sub tidy_up_SS()
'
' tidy_up_SS Macro
' Macro recorded 13/05/2004
'
' Keyboard Shortcut: Ctrl+Shift+K
'
    Range("A1").Select
    With Selection.Font
        .Name = "Arial"
        .Size = 18
        .Strikethrough = False
        .Superscript = False
        .Subscript = False
        .OutlineFont = False
        .Shadow = False
        .Underline = xlUnderlineStyleNone
        .ColorIndex = xlAutomatic
    End With
    Selection.Font.bold = True
    Range("A3:D13").Select
```

You should be able to recognise the actions you took.

For example, the first section records the macro’s name and shortcut key.

Next comes the action of selecting cell A1, changing the font to 18 point, and so on …

The macro is actually coded in a **scripting language** called Visual BASIC for Applications, or True BASICA for short.

What use is a macro?

- keep **course 2.xls** open
- open **course_copy.xls**
- hold down **Ctrl + Shift + K**.

The file **course_copy.xls** should be automatically formatted by the macro to be the same as **course2.xls**.

If the user had several similar unformatted spreadsheets and wanted them all formatted in this way, he could save a great deal of time by using the macro.

A macro is a time-saving program written in a scripting language which can be activated by a series of key strokes for repeated use. A macro cannot exist alone – it only works with an application program (in this case, Excel). In this example, we have seen a macro being used with a spreadsheet. Macros can be used with many other application packages.

Example 2: creating a word processing macro

- open any word processing document
- as before, from the **Tools** menu, select **Macro**, then **Record New Macro**
- name the macro bold_red_text
- assign a shortcut key combination (perhaps **Ctrl + Alt + R**)
- click **OK** (Now the macro is being recorded)
- select bold and text colour red from the menu bar
- click to stop the macro recording.

Now you can use the macro.

- select any block of text
- activate the macro by using the shortcut key combination.

You can also activate the macro by selecting it from Tools, Macro, Macros.

This macro would be useful if you have several documents to work through, in each of which you have been asked to change the main heading to bold red text.

If you needed to change all the sub-headings to italic blue text, you could set up another similar macro to do that. Alternatively, you could edit the macro directly by changing the True BASICA code in the edit window. Try editing the above macro to make it produce blue italic text.

The examples above are very simple ones. Macros can be used to automate any task within an application program. For example, they can be used to activate long and complex data manipulations within a database application, or specialised formatting within any type of document.

Some applications, such as AppleWorks, allow you to record macros, but don't allow you to edit the code as you can in MS Office. If you have time, you could explore any other applications that you use, to see if they have a macro facility.

Questions

1. What is a macro?
2. What type of language is used to write macros?
3. What are the advantages of using macros?
4. Describe two examples where a macro could be useful.

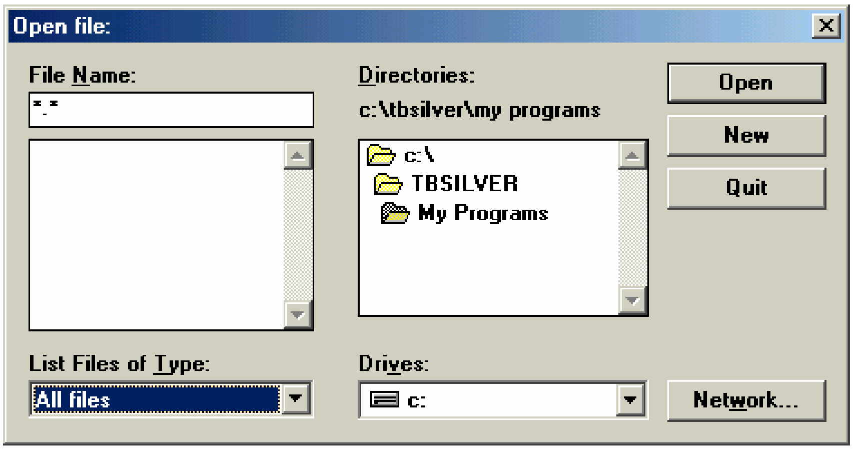
SECTION 3

3.1 Introducing True BASIC

In this section of the course, you are going to learn to develop programs using a high level language called True BASIC.

Before you start writing any programs it would be a good idea to create a new folder wherever you save your work, home drive on a network, on your hard disk or wherever. I have called my new folder **My Programs**.

The first stage is to become familiar with the True BASIC environment. Here is what you see when True BASIC starts up.



File Name: *.*

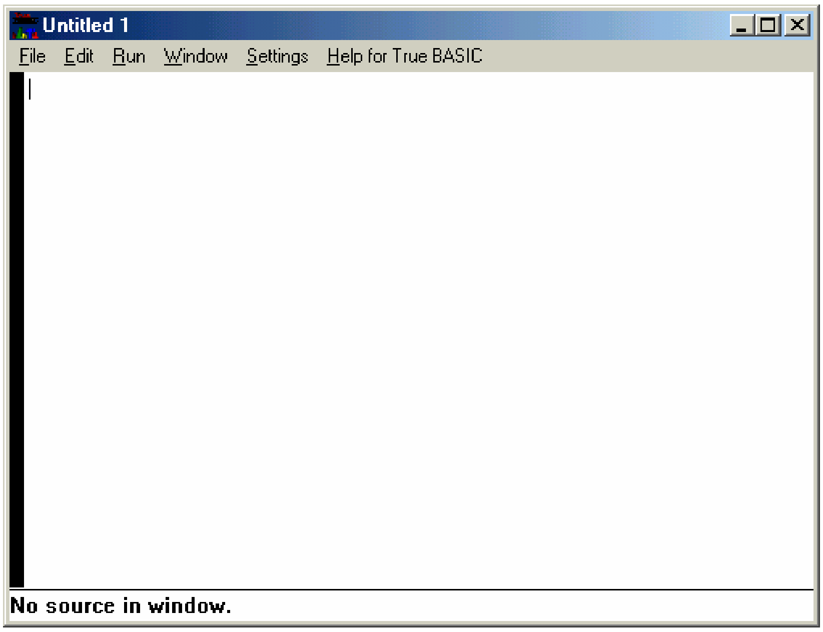
Directories: c:\tbsilver\my programs

List Files of Type: All files

Drives: c:

Navigate to your folder and open **My Programs** and your programs should save automatically into it. Make sure **All files** is selected otherwise you may not be able to find your programs.

Click on New and the following screen will appear.



No source in window.

At the top is the **menu bar**, with the usual menus (File, Edit) and some specialised menus.

There is also the Run menu, which you will use most often.

At the bottom of the screen is the Command Menu. We will not use this for quite a while except to examine occasionally to see what has happened to our program.

We are going to learn to develop True BASIC programs, using the steps of the software development process that you have already met.

Here is a reminder of these important steps.

***A**nalysis* making sure you know what the program has to do

***D**esign* deciding on the form layout, the inputs, outputs and processes required

Implementation creating the form and writing the code for any actions

***T**esting* making sure the program works correctly

***D**ocumentation* writing a user guide and a technical guide

***E**valuation* reviewing how well the program solves the original problem

***M**aintenance* making any upgrades required

3.2 Input and output – example

Almost every program that has ever been written follows a pattern called IPO. This stands for input – process – output. Most programs are designed to take in some data, to process it in some way, then to give out some data.

First True BASIC program

To keep things simple for your first True BASIC program, we are going to develop one which misses out the middle step! It will simply take in some information, and give it out again. It's not very useful, but it will teach you some of the basics of programming.

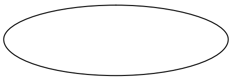
We start with the **program specification**.

Design, implement and test a program which will prompt the user to enter his or her name. The program should then display the name and a welcome message.

Stage 1 – Analysis

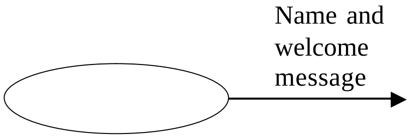
Start by thinking about what data goes in and what data comes out of the program while it is running. A data flow diagram is a good way of analysing this.

Start by representing the program as a 'blob' …



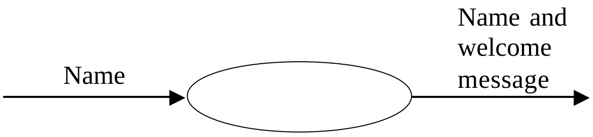
Think … what information comes out of the program?

Show this as an arrow coming out of the blob …



Now think … what information needs to go into the program to give this output?

Show this as an arrow going into the blob



Copy this diagram – you have drawn your first data flow diagram.

Stage 2 – Design – user interface

Next we need to think about what we want the program to look like.

We can write out how we want the output to look.

```
Enter your name?
James

Hello James
```

Our output has:
- a question and a question mark
- a response (James)
- an output (Hello James).

If you’re wondering where the message is going to appear, when we **Run** the program it will appear in a separate output window.

Stage 2 – Design – pseudocode

Pseudocode is just a fancy name for a list of steps that the program should carry out every time you run it. You write it in a sort of cross between English and computer language. It lets you think about the steps carefully without getting bogged down in the actual coding. Another advantage of pseudocode is that it can then be easily converted into almost any high level language you want – in our case, True BASIC.

Here is a list of steps for our program (pseudocode).

```
1. ask for the name
2. enter the name
3. display the message.
```

That’s it! That is all our program is supposed to do.

Stage 3 – Implementation – coding

Now we are ready to start coding.

Start up True BASIC on your computer and select New. In the source window type the following exactly as it written here, except for *your name* and *date* where you should type in your name and today’s date.

```
! First Program
! Your name
! Date

print “Enter your name “
input name$
print
print
print “Hello “;name$
end
```

Your program should really have capital letters for words like PRINT, INPUT and END because these are keywords. True BASIC will do this automatically for you.

Choose **Do Format** from the **Run** menu and the keywords will be put into capitals.

```
! First Program
! Your name
! Date

PRINT “Enter your name “
INPUT name$
PRINT
PRINT
PRINT “Hello “;name$
END
```

It is a good idea at this stage to save your work.

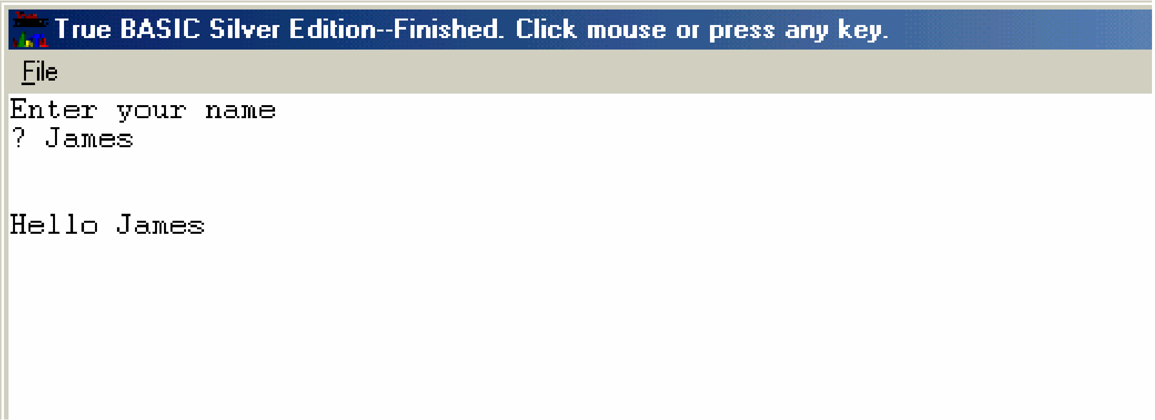
- select **Save** from the **File** menu
- navigate to your My Programs folder if necessary
- give the program a sensible name like **Welcome**, then click **Save**.

Now you can try to **run** your program.

To do this, choose **Run** from the **Run** menu.

(Note: True BASIC uses a built-in ***interpreter*** *to translate your program into machine code line by line as it executes the program. Some versions of True BASIC also have a* ***compiler****, which lets you convert completed True BASIC programs into stand-alone executable files.)*

You should see the following output screen appear.


True BASIC Silver Edition--Finished. Click mouse or press any key.
File

```
Enter your name
? James


Hello James
```

Now let us have a look at what we have done and what the keywords have done.

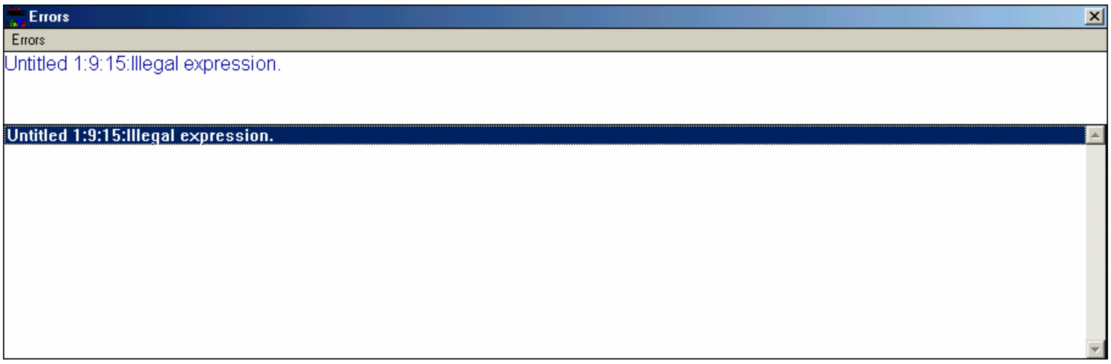
! – all text following ! is ignored. It is used for comments.
PRINT – causes everything on the line to be output on the screen.
INPUT – puts a question mark on the screen and allows us to type information in.
END – Every program needs an end statement.
PRINT – on its own prints a blank line.
We also used a variable and some other punctuation.

name$ – is a variable containing text. The $ tells us it is for text or a string of characters. If you run the program several times you can enter a different name each time. The name varies and so we call name$ a variable. Now we can call name$ a **string variable.**

“ and ; are used with PRINT. Everything inside “ “ is displayed and ; is used to separate items on a print line so we can print several items, a mix of variables and text, on the same line.

Errors

If you mistyped almost anything you will have errors. If I had missed out the ; on the print line (a very common error) I would see a screen like this one.



```
Untitled 1:9:15:Illegal expression.
```

```
Untitled 1:9:15:Illegal expression.
```

If I click on the highlighted line I will be taken to the error. The message is not very helpful as **illegal expression** could mean one of many things were wrong. The **Untitled 1:9:15** is a bit more helpful as it tells us that the error is on line 9 and 15 characters in. We can then see that the ; is missing from the print line.

If your program worked perfectly remove the ; and run it and follow the error message through and correct the program then run it again.

If your program has its own errors then follow the error message and line numbers and try and correct it.

When the program runs without errors then we can go on to the next stage, which is to test it thoroughly.

Stage 4 – Testing

The next stage is to make sure the program works correctly.

As before, Run the program.

- enter your name when prompted
- the word Hello should appear with the appropriate name in it!

If it does work, well done!

Would you buy a piece of software that had only been tested once? Probably not!

One test is not enough!

We need to test the program systematically.

So … run some more tests – some *normal* tests, like the one above – but also try some more *extreme* testing. For example, what happens if you enter a number instead of a name, or if you enter a double-barrelled name? Does it matter or does the program just print out 'Hello' and whatever you type in?

Stage 5 – Documentation

First, you might want some hard copy evidence of your program – it's your first True BASIC program, so you may feel justifiably proud of it!

Printing your program

Select **Print** from the **File** menu. A print dialogue box does not usually appear and your program prints out on the currently selected printer. Do you see now why it is important to put your name as a comment? If the whole class prints at once you can at least identify your program.

There are two ways to print the output.

1. There is a file option on the output screen and you can select **Print** from it. This will print the output screen.
2. In the box at the bottom of the Command Window you can type RUN >> and everything that is displayed will be printed.

There is a subtle difference between the two and when working with simple programs in which all output fits onto the screen use option 1 – File Print.

Saving your program

Choose **Save** from the **File** menu to save any changes you have made.

When you exit, you will be prompted to save changes to the file. Click **Yes** to both of these.

User Guide

Write a couple of sentences describing how to use your program:

User Guide
Start the program by opening First Program.

Click on the Run menu and then choose Run.

Enter your name when prompted.

A message should appear.

Technical Guide

Write a note of the types of hardware and software you have used:

Technical Guide
Hardware used:
Dell Inspiron 3500 laptop
Operating System:
MS Windows 97
Software used:
True BASIC Silver

Stage 6 – Evaluation

The evaluation of your program should answer the following questions.

1. Is the program fit for purpose? (Does it do what is required by the specification?)
2. Is the user interface good to use? Could it be improved?
3. Is the program coding readable (so that another programmer could understand how it works)?

Your answers might look like this:

Evaluation

- *The program fulfils the specification. If you enter a name, it responds with an appropriate message.*
- *The user interface is easy to use – it prompts for input, and the command button is clearly labelled.*
- *The coding has comment lines and uses sensible variable names to make it readable.*

Stage 7 – Maintenance

Maintenance might involve making the change suggested by the person who asked for the program, or adapting the program to run on a different type of computer system. You don't need to do either of these for Intermediate 2!

3.3 Input and output – tasks

Task 1 – adapt the program

Adapt the program you have already written to output a personalised Happy Birthday message. Obtain hard copies of the output and code for your new program (if your teacher/lecturer wants you to).

Instead of writing:

```
PRINT "What is your name"
INPUT name$
```

we can use INPUT PROMPT and our two lines become:

```
INPUT PROMPT "What is your name ":name$
```

Note the use of the colon (:) in INPUT PROMPT and the semi-colon (;) in a PRINT statement. Again confusion of these is a great source of errors.

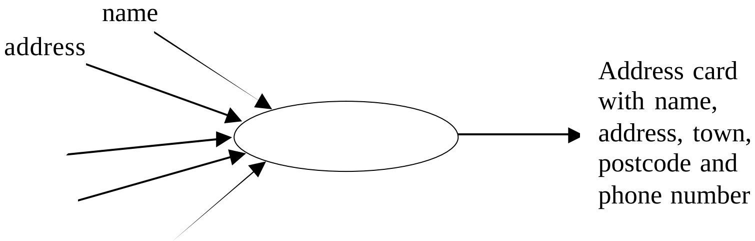
Task 2 – develop a new program

Develop a new program which asks the user to enter their name, first line of address, town, postcode and phone number, then produce an address card on the screen.

Hints for Task 2:

(a) Work through the stages of the software development process following the example on the previous pages as a model.

(b) The data flow diagram will look something like this (incomplete).


name
address
Address card with name, address, town, postcode and phone number

(c) You will need five string variables on your form, one for each of the inputs, and each with a different name.

Your code will look a bit like this.

```
INPUT PROMPT “Please enter your full name “:name$
INPUT PROMPT “Please enter the first line of your address “:address1$
…
…
INPUT PROMPT “Please enter your phone number “:telno$
Note we use telno$ because even though it is telephone number it contains a space which
makes it a string.
```

And then to output the name and address print lines will look like this.

```
PRINT name$
etc.
```

Now enter your program and correct the errors until it works properly.

Now amend the program slightly so that the output appears as:

```
Name: John Smith
…
…
Telephone Number: 01342 452345
```

3.4 Enhancing our output

In the ‘First Program’ program, the output message appeared in a **Print statement.** This was quite simple and there is not a lot we could do to enhance the output.

However the amended address program could be tidied up so that all the labels were lined up under each other and the first line of the data lined up as well such as:

```
Name:                  James Smith
…
…
Telephone Number:      01342 452345
```

We can use the TAB statement to achieve this. TAB(30) for example prints the next letter at position 30 across the screen. Our print lines now become:

```
PRINT “Name:”;TAB(30);name$
etc.
```

Amend your program so that the data is lined up under column 20.

3.5 Using variables

The programs in Sections 3.2 and 3.3 were designed to process **words** – like your name or address. The program in Task 2 also handled a phone number, but it treated this as a string of characters.

If a program has to process **numbers**, then we have to ‘tell’ the computer to expect a number rather than a ‘string’.

The reason for this (as you probably know from the Computer Systems unit) is that computers store different types of data in different ways. It is good programming practice to consider all the data that will need to be stored while the program is running. We do this at the design stage. A data flow diagram is a useful tool for doing this, although it only tells us the data that goes in and out of the program. There may also be other data which needs to be stored during the processing between input and output.

We will consider two types of data in this course.

Activity

Look at these items of data in the box below. Can you group them into two basic types?

120	1.05	699
book	29.5	Int 2
5.7	A. Einstein	–100
TD7	5700	–15.3
Monaco	0.006	9999

You might have grouped them into these two lists.

List 1:	120	699	–100	5700	9999
	29.5	5.7	0.006	1.05	–15.3
List 2:	Int 2	book	A. Einstein	TD7	Monaco

List 1 is all numbers – we call them **numeric**. So does True BASIC.

List 2 is all groups of characters – True BASIC calls these **strings**.

Activity: Classify each of the following as **string** or **numeric**.

(a) 150	(b) Bob the Builder	(c) 49.99	(d) EH16 1AB
(e) 0.5	(f) –500	(g) 5S3	(h) 123
(i) Albert	(j) –99.99	(k) 0.00006	(l) 5 High Street

True BASIC does not need to know what type of data it will be storing and processing in advance. We can use variables as we need them in the program.

The first time a numeric variable is used it has the value zero (0).

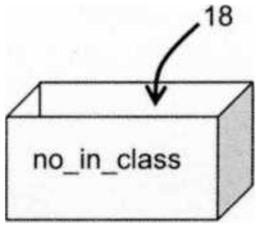
The first time a string variable is used it has the value null string (“”).

As soon as you assign a value to a variable it takes that value and we can assign values in different ways.

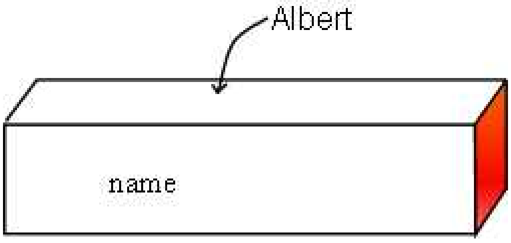
LET wage = 200	assigns 200 to the variable wage
LET name$ = “Fred”	assigns Fred to the variable name$
INPUT wage	whatever value is typed in is assigned to wage
INPUT name$	whatever string is typed in is assigned to name$
READ wage	a value for wage is held in a DATA statement and is assigned when the READ statement is executed

When the True BASIC system executes these statements during a program, it sets up a storage space of the appropriate type, in the computer’s RAM, and labels it with the variable name given. Of course, these are ‘electronic’ storage locations, but it is useful to imagine them as labelled boxes in which data can be stored, like this:

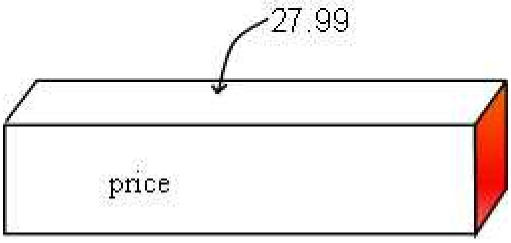
A **numeric** variable, called **no_in_class**, storing value 18



A **string** variable, called **name$**, storing value Albert



A **string** variable, called **price**, storing value £27.99



These ‘storage boxes’ are called **variables**, because the actual value of the data they store can vary or change during the running of a program.

It is important to make sure that all variables are correctly used – the right **type** (string or numeric) – and with sensible, readable **variable names**.

Variables can have almost any name, but each variable name:
- must begin with a letter
- must not be a True BASIC keyword (like END or PRINT or INPUT)
- must not contain spaces (no_in_class is OK, but no in class is not).

Note: there are several other types of variable, but we will use only these two in this unit.

3.6 Working with numbers – example

The programs in Section 3.3 were designed to process **words** – like your name or address. In this section, we will develop programs to process numbers.

The first example is called Belinda’s Slab Calculator!

Here is the problem.

Belinda works in a garden centre, selling paving stones. Customers come in with the plans for their patio, and ask how many slabs they will need, and how much they will cost. For example, Mr McInally says his back garden is 35 slabs wide and 16 slabs deep. He wants the pink granite slabs at £2.99 each. How many slabs will he need, and what will they cost?

The first step is to be absolutely clear about what the program must do. This must be agreed between the Belinda and the programmer before starting. The agreed definition of what the program must do is called the **program specification**.

Stage 1 – Analysis – program specification

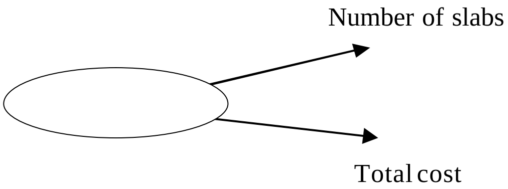
Design, write and test a program to:
- input two whole numbers (the number of slabs wide and number of slabs deep)
- multiply them together (number of slabs needed = number wide * number deep)
- input the price of a single slab
- multiply to get the total price
- display the results (number of slabs required and total cost).

The program should work for any numbers.

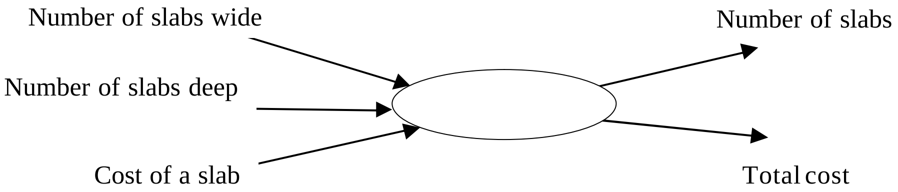
Stage 1 – Analysis – data flow diagram

A ‘blob’ for the program …

What information comes out of the program?

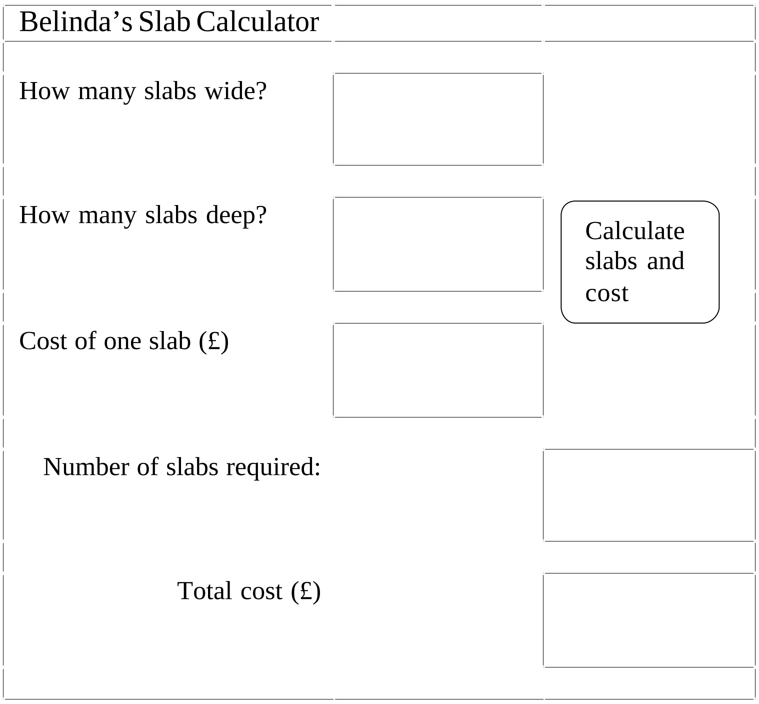


What information does the program need as input?



Stage 2 – Design – user interface

Sketch out how we want the form to look.



This program has:

- a title **heading**
- three **variables** for input
- two **variables** for output.

Stage 2 – Design – pseudocode

Here is a list of steps (pseudocode) for what this program has to do:

```
1. input and store the number of slabs wide
2. input and store the number of slabs deep
3. input and store the cost of one slab
4. calculate the number of slabs required
5. calculate the total cost
```

At the implementation stage, we will turn each of these steps into True BASIC code.

6. display the number of slabs required
7. display the total cost.

Stage 3 – Implementation – coding

Start True Basic and ask for a NEW program. When you are given the source window, type in the following code very carefully.

```
! Belinda’s Slab program
! Your name
! Date
INPUT PROMPT “Please enter the number of slabs wide “:slabs_wide
INPUT PROMPT “Please enter the number of slabs deep “:slabs_deep
INPUT PROMPT “Please enter the cost of 1 slab “:cost
LET no_of_slabs = slabs_wide * slabs_deep
LET total_cost = no_of_slabs * cost
PRINT
PRINT
PRINT “You require “;no_of_slabs;” slabs.”
PRINT “The total cost is (£)“;totalcost
END
```

If it all looks correct, then:

Run the program to make sure it is working correctly.

Enter the following data.

slabs wide : 4
slabs deep : 5
cost per slab : 2.99

The following results should appear below the inputs.

```
total number : 20
total cost (£) : 59.8
```

If it has worked correctly, save it in the correct folder (my Programs, for example).

If it doesn’t work, then go back and check for errors. The commonest mistake is to make a spelling error in the name of a variable or missing out a semicolon on the print line or a colon on the input line, so always check these carefully!

Stage 4 – Testing

Testing is a very important stage in the software development process. Proper testing of a commercially produced program may take as long as the implementation.

We will test this program methodically using normal, extreme and exceptional data.

Normal data is data that you would expect to be input to the program.

Extreme data is data that is on the limits of acceptability – it should work, but you need to check to make sure. Extreme data could include zero, or very large numbers, or numbers close to any limit relevant to the program.

Exceptional data is data that shouldn't be input under normal use – for example, entering a letter when asked for a number. True BASIC will happily accept a number in a text variable but you will not be able to do any arithmetic with it. If you try and enter text into a numeric variable you will get an error message and be asked to re-enter the data.

It is best to draw up a table of testing, choosing suitable test data, as shown below. Fill in the expected results column (what the program should do). Finally, run the program using your chosen test data, and compare the actual results with the expected results. If they agree, all is well. If not, you may need to go back and de-bug the program.

Table of testing for Belinda's Slab Calculator

	Inputs			**Expected outputs**		**Actual outputs**		**Comment**
	Wide	Deep	Cost of slab	Total number	Total cost	Total number	Total cost	
Normal data	4	5	2.0	20	40.00			
	10	20	1.99	200	398.00			
	4.5	5.9	2.99	20	59.80			
Extreme data	10000	9000	2.00	90000000	180000000			
	0	Any	Any	0	0			
	–5	–4	2.50	20	50.00			

Activity

Copy this table either in your word processor or on paper. Add some other examples of **normal** and **extreme** data to the table, then test the program to make sure it handles them all correctly.

Finally, run some **exceptional data** tests, and note the results (either in the table or as notes below it).

Summarise your testing.

The program carries out all calculations according to the specification when supplied with sensible data. However, the program does give results when supplied with negative data, without generating an error message. Also, the program does not display the total cost in the standard format (e.g. £59.80 is displayed as (£) 59.8).

Stage 5 – documentation

Print the **output** and **code** as before.

Save your working program in your correct folder especially if you have made changes to it.

Write a brief **user guide**.

Write a brief **technical guide**.

If you need a reminder how to do these, look back to pp. 30–31.

Stage 6 – Evaluation

As before, write a brief report, answering these questions.

- Does the program fulfil the specification?
- Is the user interface appropriate?
- Is the program coding readable?

3.7 Using Clear

You may want to clear away the inputs from the screen before displaying the outputs. The statement we use is CLEAR and in Belinda's slab program it would be inserted on a line of its own before the first PRINT statement.

3.8 Arithmetical expressions

In Section 3.6, the example program carried out two simple multiplications, using the lines of code:

```
no_of_slabs = wide * deep
total_cost = no_of_slabs * slab_cost
```

All other calculations can be carried out in a similar way. Some of the symbols used are the same as in 'normal' arithmetic, but some are different.

For adding, use	+
Subtraction	–
Multiplication	*
Division	/
Raising to a power	** (check your version by referring to the manual)

For complex calculations involving several operations, multiplication and division take precedence over addition and subtraction. However, where the order of the operators matters, it is safest to use brackets.

Here are some examples in True BASIC.

```
total = first + second + third
age = 2004 – birth_year
time_in_australia = time_in_scotland + 12
tax = (salary – 4600) * 0.23
years = months / 12
area_of_circle = 3.14 * (radius ^ 2)
volume_of_sphere = (4 * 3.14 * (radius ^ 3)) / 3
```

Note:
(a) the use of brackets where the order is important
(b) the use of readable variable names.

3.9 Working with numbers – tasks

Tasks for you to try.

For each task below, you should:
1. clarify the specification (analysis)
2. draw a data flow diagram (analysis)
3. sketch the user interface (design)
4. write pseudocode (design)
5. write the coding (implementation)
6. draw up a table of testing
7. test the program with normal, extreme and exceptional data
8. write brief user and technical guides (documentation)
9. evaluate the program.

(a) Design, write and test a program to calculate the average of six test marks.
(b) Design, write and test a program to calculate the volume of a cylindrical water tank, using the formula: volume = πr2h (r = radius of tank, h = height of tank).
(c) Design, write and test a program to calculate the number of points gained by a football team, given the number of wins, draws and lost games, assuming a win is worth 3 points, a draw 1 point, and no points for a lost game.
(d) Design, write and test a program to calculate the storage requirements in megabytes for a bit-mapped graphic. The inputs should be the breadth and height of the graphic in inches, the resolution in dots per inch and the colour depth in bits per pixel.

3.10 Pre-defined numeric functions

There are some standard mathematical calculations that you may want to use in your programs. True BASIC (along with most other high level languages) provides pre-defined functions to carry these out for you.

We'll take a look at some pre-defined functions provided by True BASIC.

INT takes a number and removes any fractional part, leaving the whole number part.

ROUND takes a number and returns the nearest whole number.

SQR returns the square root of any number.

and an optional extra one for anyone who has studied some maths.

SIN returns the sine of an angle (in radians) – multiply the angle by 3.14128 and divide by 180 if you want it to work for degrees.

Function tester program

We will use a simple True BASIC program to test these functions.

```
INPUT PROMPT "Please enter a number ":number
LET result = INT(number)
PRINT "The result is ";result
```

Run the program several times to test the INT function.

As you do so copy and complete a table of testing, as shown below.

Testing the INT function

Input	**Expected output**	**Actual output**	**Comment**
2.5			
9.999			
9.001			
–5.5			
–9.001			

Testing the ROUND function

Edit the coding of the program, to change:

result = INT(number)

into

result = ROUND(number).

Run the program again and complete a similar table of testing to the one above.

Can you summarise the difference between INT and ROUND?

Testing the SQR function

Edit the coding of the program, to change:

result = ROUND(number)

into

result = SQR(number).

Run the program again and complete a similar table of testing to the one above.

What happens when you enter a negative number? Can you explain this?

What happens when you enter a number like 0.00001? What does this mean?

Optional extra:

Testing the SIN function

Edit the coding of the program, to change:

result = SQR(number)

into

result = SIN(number * 3.14128 / 180)

(the 3.14128 / 180 bit is to make it work for degrees rather than radians).

Run the program again and complete a table of testing like this:

Input	Expected output	Actual output	Comment
0	0		
90	1		
180	0		
30	0.5		
–30	–0.5		

Other pre-defined functions

True BASIC provides many other pre-defined functions, including the other trigonometric functions (cosine and tangent). If you complete this unit, then continue to Higher Software Development, you will also learn to create your own functions, so that you are not limited to the pre-defined ones provided by True BASIC.

Important!
Make sure you save this function tester program as you will use it again later in the course!

3.11 Working with words and numbers – example

The next example program uses both data types – numeric and string.

The problem

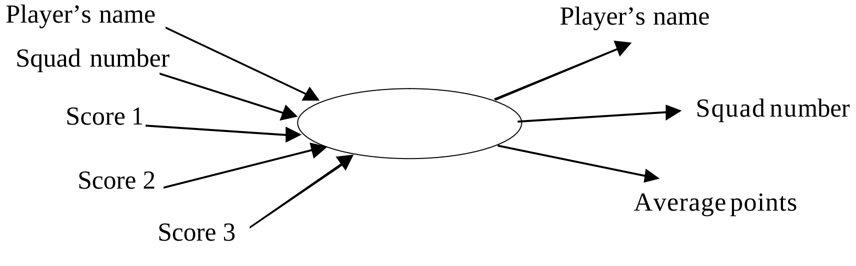
A basketball team manager wants a program which will input a player's name, squad number and points scored in the first three games of the season. It should then calculate the player's average score (to the nearest whole number), and display a summary of the player's details.

Stage 1 – Analysis – program specification

Design, write and test a program to:

- prompt the user to enter a player's name, squad number and points scored in games 1, 2 and 3
- calculate the player's average score, rounded to the nearest whole number
- display the player's name, squad number and average clearly on a form.

Stage 1 – Analysis – data flow diagram



Stage 2 – Design – user interface

This time we need input lines for player's name, number and each of three scores. We will need to calculate the average score (rounded to the nearest whole number). We will need to output and display (print lines) the player's name and number and the average score.

```
Basketball Team Manager

Please input player’s name?
Please input the squad number?
Please enter the first score?
Please enter the second score?
Please enter the third score?

The Player’s name is Magic Simpson – Squad number is 34
Average score 56
```

Stage 2 – Design – pseudocode

```
1. prompt for and store the player’s name
2. prompt for and store the player’s number
3. prompt for and store each of the three scores
4. calculate the average score
5. display the player’s name and number
6. display the player’s average score (rounded to the nearest whole number).
```

Stage 3 – Implementation – coding

```
! Basketball Team Manager
! Your Name
! Date

INPUT PROMPT “Please enter the player’s name “:name$
INPUT PROMPT “Please enter the player’s squad number “:squad_number
INPUT PROMPT “Please enter the player’s first score “:score1
INPUT PROMPT “Please enter the player’s second score “:score2
INPUT PROMPT “Please enter the player’s third score “:score3

LET average_score = ROUND((score1 + score2 + score3)/3)

CLEAR
PRINT “ Basketball Team Manager”
PRINT name$;squad_number
PRINT “Average score “;average_score
END
```

Stage 4 – Testing

Run the program to make sure it works.

You will notice that the output looks like this:

```
Belinda McSporran73
```

It would be better to make it look like this:

```
Name: Belinda McSporran
Number: 73
```

To do this, make the following changes:

Change:

```
        PRINT name$;squad_number
```

to:

```
        PRINT “Name ”;name$
        PRINT “Number “;squad_number.
```

After making these changes to improve the appearance of the output, you should carry out methodical testing of the program. Assuming that the program displays the name and squad number of the player correctly, you only need to test that it calculates averages correctly.

Draw up a table of testing with some:

- normal data
- extreme data
- exceptional data.

If there are any errors, correct them. A common error would be to misspell score in the calculation I type ‘scote’ in to begin with and could not understand why the average was very low. Of course ‘scote’ had a value of 0 as it was the first time it was used in the program.

Misspelling variables is a very common error and can cause very strange answers to calculations appearing.

Save and print the program.

Summarise your test results by completing these three sentences.

The program gives the correct result if…
The program gives a wrong answer if… because …
The program cannot give an answer if…

Stage 5 – Documentation

Now that your program is complete, write:

- a User Guide
- a Technical Guide.

Stage 6 – Evaluation

Write a brief evaluation of the program:

- is it fit for purpose?
- does it have a good user interface
- is the code readable?

3.12 Pre-defined string functions

In Section 3.10, we looked at the pre-defined functions **INT**, **ROUND**, **SQR** and **SIN**. These functions are all designed to work with numbers.

There are also some useful pre-defined functions for manipulating strings. We are going to examine **UCASE$**, **LCASE$**, **LEN**, **ORD** and **CHR$**, and a way of isolating characters in a string.

Copy this little program in True BASIC

```
! String Function Tester
INPUT prompt “Please enter a string “:string_in$
LET string_out$ = UCASE$(string_in$)
PRINT “Output string “; string_out$
END
```

Save this program as Function Tester 2.

Testing the UCASE function

Run the Function Tester 2 program.

Record the results in a table, like this, adding a few tests of your own.

UCASE pre-defined function		
Input string	**Output string**	**Comment**
Hello, world		
HELLO, WORLD		
123 One Two Three		
*?&!		

Write a brief statement summarising the effect of the **UCASE** function.

Testing the LCASE function

Edit the coding of the Function Tester 2 program.

Change:
LET string_out$ = UCASE$(string_in$)
to
LET string_out$ = LCASE$(string_in$).

Run the program to test the **LCASE** function.

Record the results in a table, like this, adding a few tests of your own.

LCASE pre-defined function		
Input string	**Output string**	**Comment**
Hello, world		
HELLO, WORLD		
123 One Two Three		
*?&!		

Write a brief statement summarising the effect of the **LCASE** function.

Testing the LEN function

Edit the coding of the Function Tester 2 program.

Change:
LET string_out$ = LCASE$(string_in$)
to
LET length = LEN(string_in$)
and also change the print line to read:
PRINT "Then length of the string is ";length

Run the program to test the **LEN** function.

Record the results in a table, like this, adding a few tests of your own.

LEN pre-defined function		
Input string	**Output string**	**Comment**
Hello, world		
HELLO, WORLD		
123 One Two Three		
*?&!		
A		

Write a brief statement summarising the effect of the **LEN** function.

Note: the Len function takes a string input, and returns a numeric output, which is why we had to change string_out$ to length or else we would have had a potential error.

Testing string-handling techniques

We can isolate letters in a string. There is not a function as such in True BASIC for doing this but there are string-handling techniques. We can also join strings together (concatenate) which is also a technique rather than a function.

mid_string$[x:n] returns the characters starting at x and going on for n characters. It would be better to see this with an example.

Edit the Function Tester 2 program to read:

```
! String Function Tester
INPUT prompt "Please enter a string ":string_in$
LET string_out$ = string_in$[1:2]
PRINT "Output string "; string_out$
END
```

Run the program and enter **Edinburgh** as your input string. The output string should be **Ed**.

Edit string_in$ so that the numbers are now [3:2]. Run the program again using **Edinburgh** and your output should be **in**.

Run the program several times to test it. Record the results in a table, like this, adding a few tests of your own until you are sure you understand how string handling works. Each time, you will need to edit the numbers in the line of code each time you run the program.

String handling techniques			
Input string	**Coding used**	**Output string**	**Comment**
Hello, world	String_in$[1:1]		
Hello, world	String_in$[2:1]		
Hello, world	String_in$[3:1]		
Hello, world	String_in$[1:2]		
Hello, world	String_in$[1:3]		
Hello, world	String_in$[5:4]		

Concatenation of strings

In True BASIC we can join two or more strings together. This could be useful for taking a forename and a surname and combining them to make a persons name. The way we do this is like this.

```
LET name$ = forename$&surname$
```

Assuming a user entered Albert and Einstein the command Print name$ would give the output:

```
AlbertEinstein
```

It would be more sensible to add in a space like this:

```
LET name$ = forename$&” “&surname$
```

Copy in this small program.

```
! String concatenation program
INPUT prompt "Enter a forename ":forename$
INPUT prompt "Enter a surname ":surname$
LET fullname$ = name$&" "&add$
PRINT fullname$
END
```

String concatenation techniques			
First input string	**Second input string**	**Output string**	**Comment**
Hello	World		
Albert	Einstein		
Your first name	Your surname		

Testing the ORD function

Edit the coding of the Function Tester 2 program. Like LEN, ORD is another function that takes a string as its input, and returns a number, so make the following changes:

Change:

```
string_out$ = String_in$[5:4]
```

to

```
number_out = ORD(string_in$).
```

and change the Print line to:

```
PRINT "Output number "; number_out
```

You will also have to make sure you only enter a single character as your input string.

Run the program to test the **ORD** function.

Record the results in a table, like this, adding a few tests of your own until you are sure you understand what ORD does.

Asc pre-defined function		
Input string	**Output number**	**Comment**
A		
B		
C		
a		
b		
c		

Write a brief statement summarising the effect of the **ORD** function.

I hope you realised that the numbers produced by the ORD function are the ASCII codes for the characters you input. As you should know from the Computer Systems unit, all characters (letters, numerals and punctuation marks) are stored in a computer system in a numeric code called ASCII (American Standard Code for Information Interchange). The **ORD** pre-defined function returns this code.

True BASIC also provides a pre-defined function to do the opposite trick. **CHR$** takes any number, and returns the character which this ASCII code represents.

Testing the CHR$ function

Edit the coding of the Function Tester 2 program. CHR$ is a function that takes a number as its input, and returns a string, so make the following changes:

change …

```
! String Function Tester
INPUT prompt "Please enter a string
":string_in$
LET number_out = ORD(string_in$)
PRINT "Output number "; number_out
END
```

to …

```
! String Function Tester
INPUT prompt "Please enter a number
":number_in
LET string_out$ = CHR(number_in$)
PRINT "Output string "; string_out$
END
```

(Note: When testing this program restrict the numbers to between 1 and 255 as these are ASCII codes.)

Run the program to test the **CHR$** function.

Record the results in a table, like this, adding a few tests to check that CHR$ turns any ASCII code into the character it represents.

CHR$ pre-defined function		
Input number	**Output character**	**Comment**
65		
66		
97		
98		
63		
20		

Write a brief statement summarising the effect of the **CHR$** function.

Questions

1. Match these pre-defined functions to their descriptions (one has been done for you):

Description		**Pre-defined function**
returns the ASCII code of a character	→	String$[x:n]
selects a group of characters out of a string		ASC
turns any character into upper case		LCASE
takes an ASCII code and returns the character it represents		UCASE
changes any character into lower case		LEN
counts the number of characters in a string		CHR$

2. If sentence$ = “What is 25 times 8?”, what would be the output from:

   (a) sentence$[1:1]
   (b) sentence$[1:4]
   (c) sentence$[9:2]
   (d) sentence$[19:1]

3. Which pre-defined functions are represented by these data flow diagrams?

any letter › ○ › string

ASCII code › ○ › character

String› ○ › n o. of characters

3.13 Example program using CHR$ and ORD

Using these two pre-defined functions you can manipulate strings in all sorts of interesting ways.

Maybe when you were younger, you tried communicating with your friends using codes.

The simplest code is the one which replaces each letter with the following letter from the alphabet, so:

A›   B
B›   C
Hello ›   Ifmmp
True BASIC ›   Usvf CBTJD
and so on …

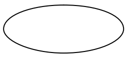
Let’s create a simple program to generate this type of code. It only works for single letters.

In Section 4.11 you will see how to code whole words or even sentences.

Stage 1 – Analysis – program specification

Design, write and test a program to take any character in the alphabet, and code it using the system A › B, etc.

Stage 1 – Analysis – data flow diagram

any letter ›  › coded letter

Stage 2 – Design – user interface

Simple character coding

Enter a character
Coded character

Stage 2 – Design – pseudocode

The program must carry out the following steps:

1. enter and store the input character
2. convert it to an ASCII code
3. add 1 to the code
4. convert it back to a character
5. display the character.

Stage 3 – Implementation

The variables needed will be:

• a **string** variable to hold the input character:	**uncoded_char$**
• a **string** variable to hold the coded character:	**coded_char$**
• an **numeric** variable for the ASCII code of the input character:	**ascii_uncoded**
• an **numeric** variable for the ASCII code of the coded character:	**ascii_coded**

Complete the program by converting each step of the pseudocode into True BASIC code.

```
! Coding Program
INPUT prompt “Letter please “:uncoded_char$        Step 1
LET ascii_uncoded = ORD(uncoded_char$)             Step 2
LET ascii_coded = ascii_uncoded + 1                Step 3
LET coded_char$ = CHR$(ascii_coded)                Step 4
PRINT “Coded Character ”;coded_char$               Step 5
END
```

Save the program as AB_code

Stage 4 – Testing

Run some tests using normal, extreme and exceptional data.

Record your results in a table.

Stage 5 – Documentation

As usual, write a brief User Guide and Technical Guide for the program, and attach a hard copy of the code.

Stage 6 – Evaluation

Write a brief evaluation of the program. You should include a note about the letter(s) which it codes **incorrectly**. You will learn how to deal with these in Section 4.3.

Congratulations! You have completed **Section 3**.

Here is a summary of what you should be able to do using True BASIC:

- analyse a problem using a data flow diagram
- write pseudocode and convert it into True BASIC code
- use string and numeric variables
- use INPUT and INPUT prompt
- use PRINT to output text and variables
- use TAB to tidy up your output.
- write True BASIC code for simple calculations
- test a program using normal, extreme and exceptional data
- use Int, Round, Sqr and Sin pre-defined functions
- use UCASE, LCASE, LEN, ORD and CHR$ pre-defined functions
- use string handling functions
- write brief User Guides and Technical Guides for simple programs
- evaluate a program in terms of fitness for purpose, user interface and readability.

Check all the items on this list. If you are not sure, look back through this section to remind yourself. When you are sure you understand all of these items, you are ready to move on to Section 4.

Note: for the Int 2 software development assessment, you need to know what pre-defined functions are, but you don’t need to know the particular pre-defined functions we have explored in this section.

SECTION 4

4.1 Making choices

So far, all the programs you have written follow the same list of steps from beginning to end, whatever data you input. This limits the usefulness of the program. Imagine a game program that was exactly the same every time you ran it!

In this section, you will learn how to make programs that do different things depending on the data that is entered. This means that you can write programs with choices for the user, and with different options and branches within them.

To do this in True BASIC is very easy, as you will see.

Here are some examples of True BASIC statements that use the keywords IF, THEN and ELSE.

If Number < 0 **Then** PRINT “That was a negative number!”
If Reply = “No” **Then** PRINT “Are you sure?”
If Salary > 5000 **Then** LET Pay = Salary – Tax **Else** LET Pay = Salary
If Guess = Correct_Answer **Then** PRINT “Well Done!” **Else** PRINT “Wrong – try again!”

The first two examples follow a simple pattern:

If *condition* **Then** *action*

We will study using this pattern in Section 4.2.

The last two examples follow a slightly more complex pattern:

If *condition* **Then** *action* **Else** *alternative action*

We will study using this pattern in Section 4.3.

Note: we will use the following symbols in this section.

>	greater than
<	less than
>=	greater than or equal to
<=	less than or equal to
=	equal to
<>	not equal to

4.2 If … Then … Else

Example 1: Credit limit

The problem: When you try to take money out of an ATM (Automatic Teller Machine, commonly called a ‘hole in the wall’), you are only allowed to withdraw cash up to your credit limit. For example, if your credit limit is £100, and you try to withdraw £50, then it should work fine.

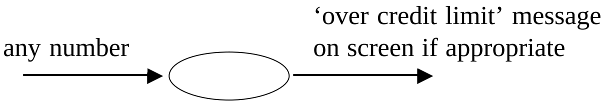
However, if you try to withdraw £150, you will not be allowed to, and a message will appear on the screen advising you that this is over your credit limit.

Stage 1 – Analysis – program specification

Design, write and test a program to:

- take a number entered by the user
- compare it with a credit limit (100)
- report ‘over the credit limit’ if the number is over 100.

Stage 1 – Analysis – data flow diagram



Stage 2 – Design – user interface

The user interface should resemble the following:

ATM – credit limit check	
How much do you wish to withdraw? Within Credit limit – withdrawal allowed.	75

OR

ATM – credit limit check	
How much do you wish to withdraw? Over Credit limit – withdrawal denied.	125

Stage 2 – Design – pseudocode

```
1. prompt for and enter amount
2. if amount is over 100, display the warning message
3. else display the allowed message.
```

There is only one variable required – a numeric variable to store the amount entered by the user.

Stage 3 – Implementation

```
! ATM Withdrawal Manager
! Your Name
! Date

INPUT prompt "How much do you wish to withdraw ":amount
IF amount > 100 then
  PRINT "Over Credit limit - withdrawal denied."
ELSE
  PRINT "Within Credit limit - withdrawal allowed."
ENDIF
END
```

When you have entered the program choose Do Format from the Run menu and not only do the keywords go into capitals but the IF lines are indented. This is very useful as if for example the END statement was indented you could see that ENDIF was missing – another common error.

Note: you must include an ENDIF statement if you cannot complete the IF…THEN statement within one line. As soon as you use ELSE it will be over one line and so ENDIF must be used.

Stage 4 – Testing

Devise some test data. This should include:

- some **normal** data, like
  20 (clearly under the limit)
  120 (clearly over the limit)
- some **extreme** data, like
  99.99 (just under the limit)
  100.00 (exactly on the limit)
  100.01 (just over the limit)
- some **exceptional** data, like
  –5 (a negative number)
  999999.9999 (a ridiculously large number)
  A (a letter when a number is expected).

Run the program, using your test data, and record the results in a table.

Stages 5 and 6 – Documentation and Evaluation

As usual, you should:

- print out hard copies of your program and the output from both runs (over and under)
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Extra task

Modify the program so that it asks your age, and gives you the message ‘You can learn to drive’ if you are 17 or over.

Note: you will need to use one of the symbols listed in Section 4.1.

4.3 Multiple Ifs

Example: Lucky Winner

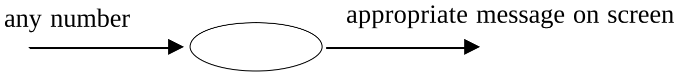
The problem: A program is required that will select a suitable prize, depending on which number between 1 and 5 is entered by the user.

Stage 1 – Analysis – program specification

Design, write and test a program to:

- prompt the user to enter a number between 1 and 5
- store the number
- output an appropriate message:
  Enter a 1 -> "You have won a colour TV"
  Enter a 2 -> "You have won a mobile phone"
  …, etc.
  (no prize if the number is not between 1 and 5).

Stage 1 – Analysis – data flow diagram



Stage 2 – Design – user interface

```
Prize Draw
Enter a number between 1 and 5

Congratulations you have won whatever prize

OR

Sorry but that number does not win a prize
```

Stage 2 – Design – pseudocode

```
1.  Prompt for a number entered by the user
2.  if the number is 1, display "You have won a colour TV"
3.  if the number is 2, display "You have won a mobile phone"
4.  …, etc.
.
.
7.  or else display message that you have not won a prize
```

There is only one variable required – a numeric variable to store the number entered by the user.

Stage 3 – Implementation

```
! Prize Draw
! Your name
! Date

INPUT prompt "Enter a number between 1 and 5 ":number
IF number = 1 Then PRINT "Number ";number;" wins you a colour TV"
IF number = 2 Then PRINT "Number ";number;" wins you a mobile phone"
IF number = 3 Then PRINT "Number ";number; " wins you a holiday in Spain"
IF number = 4 Then PRINT "Number ";number;" wins you 10p"
IF number = 5 Then PRINT "Number ";number;" wins you a day at the beach"
IF number < 1 Then PRINT "Number ";number;" Sorry but that number does not win a prize
as it is too small"
```

```
IF number > 5 Then PRINT "Number ";number;" Sorry but that number does not win a prize
as it is too large"
END
```

Stage 4 – Testing

Devise some test data. This should include:

- some normal data
- some extreme data
- some exceptional data.

Run the program, using your test data, and record the results in a table.

Stages 5 and 6 – Documentation and Evaluation

As usual, you should:

- print out a hard copy of your coding only in this case
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Practical task – adapt the 'lucky winner' program to fulfil this specification

Design, implement and test a program that asks the user to enter a grade (A, B, C, D or F), and gives you messages like 'A means you got over 70%', 'B means you got between 60% and 70%', and so on.

As usual, you should:

- print out hard copies of your coding
- save your program
- write a short user guide and technical guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Practical task – adapt the 'AB_code' program to code Z and z correctly

Remember the program we developed in Section 3.13, for coding letters using the A -> B code. When you tested it, you should have discovered that it works well for every letter, except Z. The problem is that if you add one to the ASCII code for Z you get the ASCII code for a bracket symbol.

We can correct this by using two conditional statements to cover the two special cases – upper-case and lower-case Z.

- load the program **AB_code** which you should have saved.
- alter the coding as follows (changes in bold).

```
! Coding Program
INPUT prompt "Letter please ":uncoded_char$
LET ascii_uncoded = ORD(uncoded_char$)
LET ascii_coded = ascii_uncoded + 1
LET coded_char$ = CHR$(ascii_coded)
! special case for Z and z
If uncoded_char$ = “Z” Then coded_char$ = “A”
If uncoded_char$ = “z” Then coded_char$ = “a”
PRINT "Coded Character ";coded_char$
END
```

- run the program, carefully testing that it handles Z and z correctly
- save the program as **AB_code_v2**

4.4 Using AND – example

Example: Exam Mark Grader

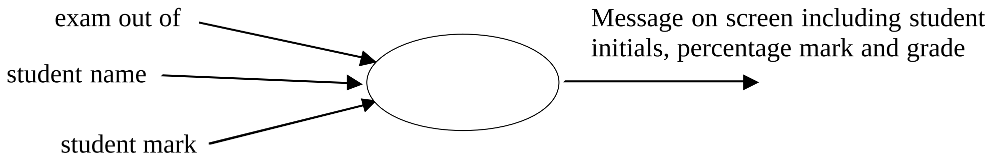
The problem: A program is required that could be used to assign grades to exam marks automatically. Over 70% is an A, over 60% is a B, over 50% is a C, over 45% is a D, and less than 45% is a fail.

Stage 1 – Analysis – program specification

Design, write and test a program to:

- prompt the user to enter the highest possible score for an exam (e.g. 80)
- prompt the user to enter a student’s name (first name and surname)
- prompt the user to enter the student’s mark (e.g. 63)
- calculate the percentage mark
- display a message displaying the student’s initials, percentage and grade.

Stage 1 – Analysis – data flow diagram


exam out of
student name
student mark
Message on screen including student initials, percentage mark and grade

Stage 2 – Design – user interface

```
Exam Mark Grader
Enter possible score
Enter student’s first name
Enter student’s surname
Enter student’s score

Student Initials
Percentage
Grade
```

Stage 2 – Design – pseudocode

```
1. prompt for and input the possible score for the exam
2. prompt for and input the student's first name
3. prompt for and input the student's surname
4. prompt for and input the student's mark
5. calculate the percentage mark
6. calculate the grade
7. extract the initial letter from the first name
8. extract the initial letter from the second name
9. display the student initials
10. display the student percentage mark
11. display the grade.
```

The program will use several variables. It is useful to write them down as a table.

Variable name	Variable type	used to store
Max_mark	Numeric	What the exam is out of (e.g.80)
First_name$	String	Student's first name (e.g. Albert)
Surname$	String	Student's surname (e.g. Einstein)
Mark	Numeric	Student's actual mark (e.g. 63)
Percent	Numeric	Student's percentage (e.g. 53.7)
Grade&	String	Student's grade (e.g. D)
Init1$	String	Student's first initial (e.g. A)
Init2$	String	Student's second initial (e.g. E)

Converting the pseudocode into True BASIC, we should get the following code.

Stage 3 – Implementation

```
! Exam Mark Grader
! Your name
! Date
INPUT prompt "What is the exam marked out of ":max_mark
INPUT prompt "Please enter your first name ":forename$
INPUT prompt "Please enter your second name ":secname$
INPUT prompt "What is this student's mark ":mark

LET percent = ROUND((mark / max_mark) * 100)
IF percent >= 70 Then LET grade$ = "A"
IF percent >= 60 AND percent < 70 Then LET grade$ = "B"
IF percent >= 50 AND percent < 60 Then LET grade$ = "C"
IF percent >= 45 AND percent < 50 Then LET grade$ = "D"
IF percent < 45 Then LET grade$ = "Fail"

LET init1$ = forename$[1:1]
LET init2$ = secname$[1:1]

CLEAR
PRINT "Exam Mark Grader"
PRINT "Student ";init1$;init2$
PRINT "Percentage ";percent
PRINT "Grade ";grade$
END
```

Stage 4 – Testing

Devise some test data. This should include:

- some **normal** data
- some **extreme** data
- some **exceptional** data.

Run the program, using your test data, and record the results in a table.

Stages 5 and 6 – Documentation and evaluation

Don't print out your program or write documentation or an evaluation report yet, as you are going to make some minor improvements to the program first.

Extra task (1): Upper Case Initials

If you entered a student's name as (for example) "albert einstein", the initials would be displayed as "ae". It would be better if they were changed automatically to "AE". A simple change in the coding is required.

Hint: you will need to use the ***Ucase*** *pre-defined function.*

Extra task (2): A+ grade

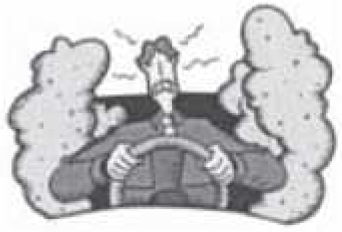
A new grade called A+ has been introduced for marks of 80% and over. Change the coding to reflect this new grade. Remember to change the condition for an A as well as introducing a new condition for A+.

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

- print out a hard copy of your coding
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

4.5 Using AND – task



Example: Can I drive?

The problem: A program is required that asks the user to enter their age, then displays one of the following messages, as appropriate:

- Sorry, you can't drive (if you are under 16)
- You can only drive a moped (if you are 16)
- You can only drive a car or moped (if you are 17–20)
- You can drive any vehicle (if you are 21–74)

- You need a medical check (if over 75).

Design, implement and test a program to solve the problem given above.

4.6 Complex conditions

In section 4.4, we used a conditional statement with an AND in it:

If percent >= 60 AND percent < 70 THEN grade$ = “B”

This is an example of a complex condition.

Complex conditions use a combination of the terms **AND**, **OR** and **NOT** in logical combinations.

Here are some examples:

If age > 60 **AND** gender = “F” **THEN** pension = “true”

If country = “UK” **OR** country = “USA” **THEN** language = “English”

If (temp < 12 **AND** heating = “T”) **OR** Heating = “X” **THEN** turn_heating_on

If Not(password = correct_password) **THEN** MsgBox “Try again”

If age < 5 **OR** Age > 85 **THEN** eligible = “No”

If Not(age >=5 **AND** age <=85) **THEN** eligible = “No”

Note: the last 2 examples are equivalent to each other!

If Answer = “Too” **OR** Answer = “Two” **OR** Answer = “To” **THEN** Correct = “True”

Programming task – colour chooser

Design, write and test a program that asks the user to enter a letter, and prints the word:

- red if R or D is entered
- green if G or N is entered
- blue if B or E is entered
- yellow if Y or W is entered
- black if C, A or K is entered.

The program should respond to both upper case and lower case inputs.

4.7 Repetition

So far, every program you have written starts at the beginning, executes each line once, then stops at the end. If you want to repeat the program you have to run it again. It is often useful in a program to be able to repeat a line or group of lines automatically.

To do this, you can use a FOR … NEXT loop.

Here is a simple example program that would benefit from a FOR … NEXT loop.

Enter this coding:

```
! code to display 10 greetings on the screen
! by a not very good programmer
! who hasn't been taught about FOR…NEXT loops

Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
Print "Have a nice day!"
END
```

Now run the program. It should print "Have a nice day!" ten times on the screen.

Here is a second version of the program that uses a FOR … NEXT loop to cut down the amount of coding required:

```
! code to display 10 greetings on the screen
! by a much better programmer
! using a FOR … NEXT loop

For counter = 1 To 10
Print "Have a nice day!"
Next counter
END
```

Alter the coding as shown and run the program again. It does exactly the same thing, but takes much less coding.

4.8 Repetition using For … Next

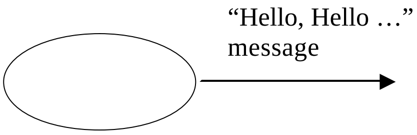
In this example, we will develop a program to display a repeated message across the screen.

Stage 1 – Analysis

Program specification

Design, write and test a program to display the message:
"Hello, Hello, Hello … (25 times)".

Data flow diagram



Stage 2 – Design

We want the user interface to look like this:

Hello Hello Hello … Hello

Next, we design the list of steps (pseudocode) and then the coding.

Pseudocode

```
1. Do the following 25 times
2. Display the word “Hello” in a line
```

True BASIC coding

```
For Counter = 1 to 25
        Print “Hello “;
Next Counter
```

*Note that it is usual to **indent** the code within the loop to improve readability. Note also that a semi-colon (;) at the end a print line suppresses the line feed.*

Stage 3 – Implementation

This is quite a simple program so enter it in yourself, run it and make it error free and the save it.

Stage 4 – Testing

There is no need for a table of testing for a simple program like this.

Modifications (1)

Alter the coding so that it displays the message:
(a) “Goodbye” 12 times
(b) “I must work harder” 200 times
(c) “This is very easy” 100 times.

Modifications (2)

The program would be much more useful if it was possible to make changes to the message and the number of times it was displayed, without having to alter the coding each time. This can be achieved by using **variables**.

Change the coding as follows:

```
! Improved For … Next example

Input prompt “Message Required …”:message$
Input prompt “How many repetitions “:how_many

Clear

For counter = 1 To how_many
Print message$
Next counter
End
```

A string variable called **message** will store the message, and a numeric variable called **how_many** will store the number of repetitions.

This command clears the screen

Instead of a fixed number here, the loop will continue up to the number stored in **how_many**.

Whatever string is stored in the variable called **message** will be displayed in the list box.

Testing (continued)

Now test the program thoroughly using **normal**, **extreme** and **exceptional** values for both “message” and “how_many”.

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

- print out a hard copy of your coding
- save your program
- write a short user guide and technical guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Modifications (3)

At the moment, this program can display any message over and over again, but it is the same message on each line.

Can you adapt the program to produce displays like:

```
Tick      Left       Go home
Tock      Right      Now!
Tick      Left
Tock      Right      Go home
Tick      Left       Now!
Tock      Right
Tick      Left       Go home
Tock      Right      Now!
Tick      Left
```

Hint: you will need two (or three) lines of code within the For … Next loop.

4.9 Counting using For … Next

The standard For … Next loop that we have used so far is of the format:

```
For counter = 1 to maximum
Action
Next counter
```

Note that we have called the loop variable ‘counter’ (because that is what it does), but it can be called anything you like. The following versions would work in exactly the same way:

```
For silly_name_for_a_variable = 1 to maximum
Action
Next silly_name_for_a_variable
```

```
For i = 1 to maximum
Action
Next i
```

The last of these (using i as the loop variable) is probably the commonest as it is less typing and will become more obvious later.

For … Next loops are an example of ‘**fixed loops**’. This is because the number of times the action is executed is fixed in advance by the programmer, using the value of maximum. Later, we will see that it is possible to construct loops where the number of times the action is executed is NOT known in advance.

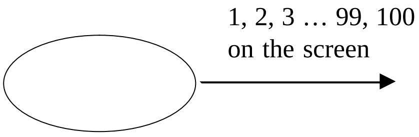
Example 4.9.1: Counting program

Stage 1 – Analysis

Program specification

Design, write and test a program to display 1, 2, 3, 4, 5 … 99, 100.

Data flow diagram



Stage 2 – Design

We want the user interface to look like this.

```
Counting program
1, 2, 3, …, 100
```

Here is the list of steps (pseudocode) and then the coding for the command button.

Pseudocode	**True BASIC coding**
1. Do the following 100 times	For counter = 1 to 100
2. Display the **counter** on the screen	Print counter;
	Next counter
3.	*Instead of 'message' being displayed on the screen the current value of counter is displayed instead.*

Stage 3 – Implementation

```
! Counting program
FOR counter = 1 to 100
        PRINT counter;
NEXT counter
END
```

Stage 4 – Testing

Run the program to make sure it works correctly (it should produce a list of numbers from 1 to 100 on the screen over several lines).

There is no need for a table of testing for a simple program like this.

You are going to use this program as a template to experiment with For … Next loops. In each case below:

- replace the line of code **For counter = 1 To 100** with the modification suggested
- run the program
- note the results in a table like this.

coding used	**results**
For counter = 1 To 100	1 2 3 4 … 99 100

Modification (1) For counter = 1 To 9999

Modification (2) For counter = 1 To 100 Step 2

Modification (3) For counter = 2 To 100 Step 2

Modification (4) For counter = 0 To 100 Step 10

Modification (5) For counter = –10 To 10 Step 5

Modification (6) For counter = 100 To 1 Step –5

Modification (7) For counter = 0 To 5 Step 0.5

Questions

Write the True BASIC coding of a For … Next loop to produce each of the following lists of numbers:

(a) 3, 6, 9, 12, 15, 18 … 33, 36
(b) 0, 9, 18, 27 … 99
(c) 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0
(d) 0, 0.75, 1.5, 2.25, 3, 3.75, 4.5
(e) 50, 40, 30, 20, 10, 0, –10, –20, –30, –40, –50
(f) 1, 4, 9, 16, 25, 36, 49, 64, 81, 100 *(hint: these are all numbers* ***squared****)*
(g) 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 *(hint: these are* ***powers of 2****)*.

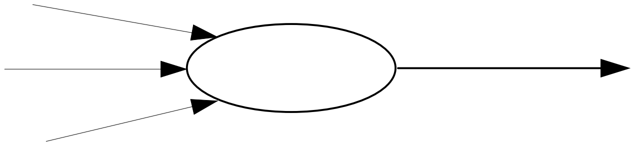
Example 4.9.2: General purpose counting program

Stage 1 – Analysis

Program specification

Design, write and test a program to display any list of numbers, given the starting number (lower limit), the final number (upper limit) and the step size.

Data flow diagram (copy and complete …)



Stage 2 – Design

Sketch a user interface, something like this.

General counting program
lower limit
upper limit
step size

Here is the list of steps (pseudocode). Copy and complete the coding yourself:

Pseudocode	True BASIC coding
1. store the lower limit entered by the user	Input prompt “Lower Limit “:lower
2. store the upper limit entered by the user	Input prompt “Upper Limit “:upper
3. store the step size entered by the user	Input prompt “Step size “:step
4. repeat the following, starting at lower limit, and going up to upper limit in steps of step size	For … = … To … Step …
5. display the counter.	Print …
	Next …

Stage 3 – Implementation

Enter the code and free the program of errors, then save it.

Stage 4 – Testing

Carry out systematic testing of the program, completing a table like this:

	Inputs			**Expected outputs**	**Actual outputs**	**Comment**
	Lower limit	Upper limit	Step size			
	10	20	3	10, 13, 16, 19		
Normal data	1000	8000	2500	1000, 1250, 1500, 1750		
	10	0	–2	10, 8, 6, 4, 2, 0		

Devise your own test data, covering a range of normal, extreme and exceptional data.

Write a short summary of your testing.

If all the tests results were as expected, move on to stages 5 and 6. If not, go back and correct your coding until it works correctly.

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

- print out a hard copy of your coding
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

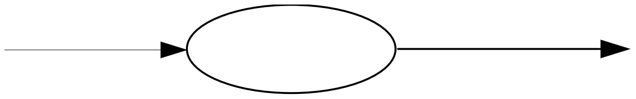
Example 4.9.3: Multiplication tables

Stage 1 – Analysis

Program specification

Design, write and test a program to display any multiplication table (chosen by the user) in the form: 1 × 5 = 5, 2 × 5 = 10 and so on as far as 12 × 5 = 60.

Data flow diagram (copy and complete)



Stage 2 – Design

Sketch a user interface, something like this:

It should ask the user to enter a table.

Each line that appears on screen should look like this (made up of five parts):

1	×	5	=	10
the counter (1,2,3…)	*the symbol ×*	*the multiplier chosen by the user*	*the symbol =*	*the answer (counter × multiplier)*

To do this, we need several variables:

- the counter (numeric)
- the multiplier (a numeric supplied by the user)
- the answer (a numeric calculated by the program).

The line of code to print each line will look like:

PRINT counter;" X ";multiplier;" = ";answer

Here is the list of steps (pseudocode).

Copy and complete the coding yourself:

Pseudocode	**True BASIC coding**
1. Store the multiplier entered by the user	Input prompt "What table do you want ":multiplier
2. Repeat the following from 1 to 12 Step …	For … = … To …
2.1 calculate the answer	answer = counter * multiplier
2.2 display the message	Print …
5. Next	Next …

Stage 3 – Implementation

Enter the code from the table completing the lines yourself.

Stages 4, 5 and 6 – Testing, documentation and evaluation

Complete the testing, documentation and evaluation of the program in the usual way.

4.10 For … Next tasks

Choose one (or more) of the following program specifications, and design, implement and test a program to fulfil the specification. Work through all the stages of the software development process from analysis to evaluation for your chosen task.

Remember: A Dance In The Dark Every Monday! (See p. 10.)

Times tables (advanced version)

A primary school teacher wants a program that will allow a pupil to type in any whole number. The program will then display the relevant times table, up to a maximum multiplier set by the pupil. The display should be in the format:

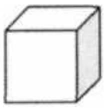
```
5 times 1 equals 5
5 times 2 equals 10
5 times 3 equals 15 and so on …
```

Cost and weight calculator

A greengrocer needs a program which will allow him to type in the price of 1 kg of any item. The program should then display the cost of 0, 0.1, 0.2 … up to 1.8, 1.9, 2.0 kg of the item. The output might look something like this:

```
0 kg costs £0
1.1 kg costs £0.20
1.2 kg costs £0.40
1.3 kg costs £0.60 and so on …
```

Cubic numbers



A mathematician wants a list of cubic numbers (1, 8, 27, 64, 125 …) starting and finishing at any point on the list. The results should be displayed like this:

```
2 cubed = 8
3 cubed = 27
4 cubed = 64 and so on …
```

Quadratic function calculator

A student has been asked to draw a graph of the function $y = 3x^2 + 4$. She needs a table of the values of the function between –5 and +5. She is not sure about the step size between points, so wants the program to allow her to choose any step size.

The results should be displayed like this:

```
x = 1 >>>>>>>> y = 7
x = 2 >>>>>>>> y = 16
x = 3 >>>>>>>> y = 31 and so on …
```

4.11 Using the loop counter

So far, we have only used the loop counter variable to display numbers. However, it can be used to do other things too. In this example program, the loop counter is used to work its way through the word to be coded. In later sections, we will see how it can be used with ‘arrays’ to access numbered items of data.

Example 4.11.1 – adapting the AB_coder program to code whole words

Version 2 of the AB_coder program from Section 4.3 can code single characters. We can use a For … Next loop to adapt the program to code whole words instead of single characters.

Here is how it works (in pseudocode):

```
1. prompt the user to enter a word
2. check how many characters there are in the word
3. create a new ‘empty’ coded word
4. repeat the following for each letter in the word
        4.1. extract the letter from the word
        4.2. code it
        4.3. add it on to the new coded word
5.  next letter
6.  display coded word …
```

… and here is the code (new code is in bold):

```
! Coding Program - Whole Word converter
INPUT prompt "word please ":uncoded_word$
LET length_of_word = LEN(uncoded_word$)
LET conded_word$=””
FOR counter = 1 to length_of_word
        LET uncoded_char$ = uncoded_word$[counter:counter]
        LET ascii_uncoded = ORD(uncoded_char$)
        LET ascii_coded = ascii_uncoded + 1
        LET coded_char$ = CHR$(ascii_coded)
        IF uncoded_char$ = "Z" Then LET coded_char$ = "A"
        IF uncoded_char$ = "z" Then LET coded_char$ = "a"
LET coded_word$ = coded_word$&coded_char$
NEXT counter
PRINT "Coded word ";coded_word$
END
```

Load up the **AB_code_v2** program, and alter the coding like this. Save it as AB_coder_v3

Test the program thoroughly using normal, extreme and exceptional data.

4.12 Do … Loop Until

We have used **For … Next loops** to repeat a section of program a set number of times. This is fine if we know how many times the section of program is to be repeated. What about when the number of repetitions is unknown in advance?

For example, a quiz program might give the user repeated chances to get the answer correct. The programmer doesn't know in advance whether the user will get the question right first time, or take 2, 3, 4 or more attempts.

In this type of situation, the programmer needs to use another kind of loop. True BASIC provides several other types of loop. We will use a type called **Do … Loop Until**.

The pattern (syntax) for this type of loop is very simple.

```
Do
   Line(s) of code
   To be repeated
Loop Until condition
```

Here is a simple example.

```
! generates a question to the user
! and waits for the correct answer
LET correct_answer = 4
DO
 INPUT prompt "What is 2 + 2 ":user_answer
LOOP Until user_answer = correct_answer
PRINT "Well done!"
END
```

Run the program. Does it behave as predicted?

Adapt the program to ask:
(a) a different arithmetical question (e.g. What is 100×100?)
(b) a general-knowledge question (e.g. Who won Big Brother in 2003?).

Improvements to the program

This simple program works fine, but there are some obvious changes that would improve it!

Improvement 1

When you give the wrong answer, the program doesn't tell you. It could be improved by presenting a message which told the user to try again.

To do this, you need to add in the following line of code:

If user_answer <> correct_answer Then PRINT "Wrong, try again!"

Can you work out where this line of code should go?

Edit it into your program, and check that it works.

Improvement 2

The program would be improved if it told you how many guesses you made before you got the correct answer.

To do this, we need to include a **counter** in the loop.

Here is the pseudocode (the new sections are in bold).

```
1. Set the counter equal to zero
2. Set the correct answer equal to 4
3. Do
   3.1. Get the user's answer to the question (What is 2 + 2?)
   3.2. Add one to the counter
   3.3. If the answer is not the correct answer, display "Wrong, try again" message
4. Until user's answer is equal to the correct answer
5. Display message (You took counter tries to get that right)
```

The code for this is
LET counter = counter + 1

Turn the pseudocode into True BASIC, and adapt your program accordingly.

Edit the changes into your program, and check that it works.

Improvement 3

The third improvement would be if the program could be made to ask a different question each time, instead of always asking 2 + 2. To do this, we need to use True BASIC's random number generator.

4.13 Random numbers

True BASIC provides the programmer with a pre-defined function **RND** to generate random numbers. RND generates a random number between 0 and 1 in the same sequence every time. To vary the sequence we use the command RANDOMIZE at the start of the program. Before we use it in the arithmetic tester program, we will use a simple program with a For … Next loop to learn how the **RND** function operates.

Enter the following coding.

```
! Generates lists of random number
FOR counter = 1 To 10
LET number = Rnd
PRINT number
NEXT counter
END
```

Run this program.

Write down the list of ten random numbers produced.

The **RND** function produces random numbers **between 0 and 1**.

To produce **random whole numbers between 1 and 10**, we need to do three things to the line **LET number = RND**.

- First, we need to **multiply by 10** to produce a random fraction between 0 and 10.
- Then we need to 'chop off' the fraction part using the function **INT** (see Section 3.10).
- Finally, we need to **add 1**, otherwise the highest number will always be 9, as it is rounded down by the INT function.

Edit the line: **LET number = RND**
To: **LET number = INT (RND * 10) + 1**

Now run the program again. Write down the list of random numbers.

This time they should all be whole numbers between 1 and 10.

Stop the program.

Run the program again. AND again!

Notice that it always generates the **same** list of 'random' numbers. To make them really random, you need to add the keyword **RANDOMIZE** at the start of the program (anywhere before the keyword **RND**). The coding for your random number generator should now look like this:

```
! Generates lists of random number
RANDOMIZE
FOR counter = 1 To 10
  LET number = INT (RND * 10) + 1
  PRINT number
NEXT counter
END
```

For example, to produce:

random numbers between 1 and 20, change it to:
LET number = INT (RND * 20) + 1

random numbers between 51 and 60, change it to:
LET number = INT (RND * 10) + 51

random **even** numbers between 0 and 10, change it to:
LET number = 2 * INT (RND * 6)

Try experimenting with this line until you understand how it works. Sometimes it takes a little thought to work out exactly what numbers to put in, so that you get the right range and don't miss out the highest or lowest number.

Test your program with the following lines of code. In each case, make a note of the results, and explain what you get.

line of code	**results**	**explanation**
LET number = INT(RND * 200) + 1		
LET number = INT(RND * 20) + 1		
LET number = INT(RND * 100) + 2000		
LET number = 2 * (INT(RND * 50) + 1)		
LET number = 2 ˆ (INT(RND * 8) + 1)		

Tasks

- Modify your program so that when you run it, it produces a single dice roll (a random number between 1 and 6).

Hint: you won't need a For … Next loop.

- Modify your program so that it produces a double dice roll, and displays the number on each die **and** the total score.

Hint: you will need to generate two random numbers every time you run the program.

4.14 Arithmetic tester

We can now combine what we have learned about random numbers with our arithmetic tester program from Section 4.12.

Here is the current version of the program.

```
! generates a question to the user
! and waits for the correct answer
LET correct_answer = 4
DO
  INPUT prompt "What is 2 + 2 ":user_answer
LOOP Until user_answer = correct_answer
PRINT "Well done!"
END
```

- Modify the coding as shown (changes in bold):

```
! generates a random question to the user
! and waits for the correct answer

Randomize
LET first = INT(RND * 10) + 1
LET second = INT(RND * 10) + 1
LET counter = 0
LET correct_answer = first + second
DO
PRINT “What is ” ; first ; “ + ” ; second ; “? ”;
INPUT user_answer
LET counter = counter + 1
If user_answer <> correct_answer PRINT “Wrong, try again!”
LOOP Until user_answer = correct_answer
PRINT “Well done! You took ” ; counter ; “ tries”
End
```

These lines generate the two random numbers for the question.

Print (rather than Input Prompt) displays the value of the variables first and second, rather than the numbers 2 + 2.

One more modification!

The program only asks **one** random addition question each time it is run. By adding three lines of code, we can make it give the user a series of (say) six questions. We can do this by putting the whole of the middle section of the program inside a For … Next loop, like this:

```
! generates 6 random question to the user
! and waits for the correct answer

Randomize
For question = 1 To 6
LET first = INT(RND * 10) + 1
LET second = INT(RND * 10) + 1
LET counter = 0
LET correct_answer = first + second
PRINT “Question “;question
DO
PRINT “What is ” ; first ; “ + ” ; second ; “? ”;
INPUT user_answer
LET counter = counter + 1
If user_answer <> correct_answer Then PRINT “Wrong, try again!”
LOOP Until user_answer = correct_answer
PRINT “Well done! You took ” ; counter ; “ tries”
NEXT
END
```

Here is the For … Next loop to repeat the next section six times.

You now have a loop within a loop. The technical term for this is **nested loops**.

Make the above changes to the coding.

Save the revised program under a new name.

Carry out some thorough testing of your program, using normal, extreme and exceptional data.

Modify the program so that it:
(a) asks multiplication questions rather than addition
(b) uses random numbers between 1 and 12
(c) asks five questions
(d) displays “Well done – right first time!” if the user gets it right first time
(e) displays “Keep practising! You took X tries to get it right!” if the user doesn’t get it right first time.

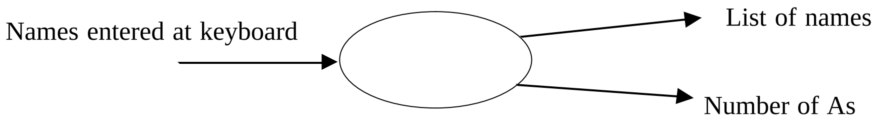
Test the program using normal, extreme and exceptional data.
Write brief User and Technical Guides, and an evaluation report.

4.15 More examples using Do … Loop Until

Example 4.15.1 – Class lists

Design, write and test a program for a tutor. The program should prompt the user to enter any list of names, which will be displayed on the screen. The program should count how many of these names begin with the letter A, and display this information at the end of the list.

Stage 1 – Analysis – data flow diagram



Stage 2 – Design

We want the user interface to look like this:

```
Class lists
Enter a name please
…
…
Enter a name please

?? names begin with A
```

Next, we design the list of steps (pseudocode) and then the coding:

Q: *We will need to use a loop. Should it be a For … Next loop, or a Do … Loop Until?*

A: As we don’t know in advance how many names there will be in the list, we need to use a **Do … Loop Until**.

***Q**: What condition will we use to stop the loop?*

A: Ask the user to enter the word END after entering all the names. The loop can then continue **until name = “END**”.

Pseudocode	**True BASIC coding**
1. set a counter equal to zero	counter = 0
2. do the following:	Do
2.1 prompt the user to enter a name	INPUT prompt “Enter a name (or END)” :name$
2.2 extract the first letter of the name	LET initial$ = name${1:1]
2.3 if the first letter is A, add 1 to the counter	If initial$ = “A” Then counter = counter + 1
2.4 until the user enters end	Loop Until name = “END”
3. display the number of A’s	PRINT “There were “;counter;” As”

Variables required:
counter (numeric), name (string), initial (string)

Stage 3 – Implementation

Given the above coding see if you can enter the code yourself, remove any errors and save the program.

Stage 4 – Testing

Test the program with the following sets of test data, and add some more of your own.

	test data 1	test data 2	test data 3		
test data	Andrew Bill Cliff Doris Sarah	Alison Albert Bill Bert Ahmed	Alison Alison End END		
comment					

You should have noticed three problems with the program:

- it doesn’t count names which start with a **lower case** ‘a’
- it doesn’t stop when you enter ‘end’ in **lower case**
- it counts the word END as a name.

You should be able to modify your code to solve these problems.

Hints:

- use the function UCASE in step 2.2
- make the end of loop condition into a complex condition using OR.

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

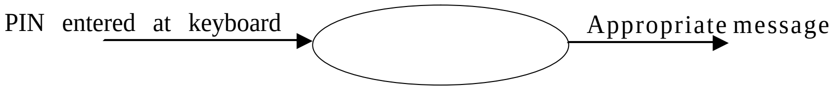
- print out a hard copy of your program

- save your program
- write a short user guide and technical guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Example 4.15.2 – Password protection

Design, write and test a program for a bank cash machine. The program should prompt the user to enter their PIN. If the PIN is correct, it should display “Welcome to the True BASIC Bank” (message 1). If not, it should notify the user that their PIN was entered wrongly (message 2), and let them try again, but only allow three tries. If the user enters their PIN wrongly three times, they should be warned that their card is being kept (message 3).

Stage 1 – Analysis – data flow diagram



Stage 2 – Design

We want the user interface to look like this:

```
True BASIC Bank
Please enter PIN

Welcome to the True BASIC bank
```

The user will be prompted to enter their PIN.

First, we design the list of steps (pseudocode) and then the coding for the program. We will use a **Do … Loop Until**, as the number of attempts the user makes is unknown in advance by the programmer.

The condition to end the loop will be that the PIN is correct OR that the user has had three attempts.

Pseudocode	**True BASIC coding**
1. set a counter equal to zero	LET counter = 0
2. store correct PIN	LET correct_pin = 1347
3. do the following:	Do
3.1 prompt the user to enter their PIN	INPUT prompt “Enter your PIN”:pin
3.2 If PIN is correct display message (1) Else display message(2)	If pin = correct_pin then PRINT Welcome to True BASIC Bank” Else PRINT “PIN entered wrongly – try again”
3.3 add 1 to the counter	LET counter = counter + 1
4. until the PIN is correct or counter = 3	LOOP Until pin = correct_pin Or counter = 3
5. If counter = 3 then display message(3)	If counter = 3 Then PRINT “The card is being kept for security”

Variables required:
counter (numeric), pin (numeric), correct_ pin (numeric)

Stage 3 – Implementation

Given the above coding see if you can enter the code yourself; remove any errors and save the program.

Stage 4 – Testing

Create some suitable test data, and use it to test the program.

	test data 1	test data 2	test data 3		
test data	1347	9999 8888 1347	1234 4321 9999		
comment					

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

- print out a hard copy of your program
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

Task

Modify the program to:

- prompt the user to enter a password (which could contain letters as well as numbers)
- allow five attempts at guessing the password.

4.16 Other forms of conditional loop

There are four variations of conditional loop in BASIC. So far, we have only used the Do … Loop Until form of loop. In some high level languages, this is the only kind of conditional loop, and it is possible to manage without the other kinds. However, for completeness, here is a brief summary of all four.

type of loop	**syntax**	**comments**
Do … Loop Until	**Do** *Line(s) of code to be repeated* **Loop Until** *condition*	always executed at least once, as condition is tested at the **end**; stops when the condition becomes **true**
Do Until … Loop	**Do Until** *condition* *Line(s) of code to be repeated* **Loop**	only executed if the condition is true, as it is tested at the **beginning**
Do … Loop While	**Do** *Line(s) of code to be repeated* **Loop While** *condition*	loops **while** the condition is true, and stops when the condition becomes **false**
Do … While Loop	**Do While** *condition* *Line(s) of code to be repeated* **Loop**	only executed **while** the condition is true, as it is tested at the **beginning**

Question
Do I need to know about all four types?

Answer
No, for this unit it is enough to be able to use one type of conditional loop!

Congratulations! You have completed Section 4.

Here is a summary of what you should now be able to do using True BASIC:

- analyse a problem using a data flow diagram
- write pseudocode, convert it into True BASIC code, and assign it to an event
- identify string and numeric variables
- use Input and Print statements
- test a program using normal, extreme and exceptional data
- use a range of pre-defined functions
- write brief User Guides and Technical Guides for simple programs
- evaluate a program in terms of fitness for purpose, user interface and readability
- use conditional statements involving If, Then, Else and End If
- use simple and complex conditions involving comparison operators, AND, Or and Not
- create fixed loops using For … Next
- create conditional loops using Do … Loop Until
- make use of the loop counter within a loop
- create nested loops (a loop within a loop).

Check all the items on this list. If you are not sure, look back through this section to remind yourself. When you are sure you understand all of these items, you are ready to move on to Section 5.

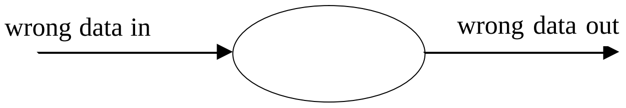
SECTION 5

5.1 Input validation

There is a saying in Computing, which goes:

Garbage in, garbage out! (or just **GIGO**)

You have probably heard stories about people who have received a gas bill for £1,000,000 or similar. Usually the company will blame this on a ‘computer error’. However, computers very rarely make mistakes! More often, the problem is that the computer has been fed with the wrong data to start with. If you feed in wrong data, then the answer that comes out of the system will be wrong too.



A well designed program should prevent (or at least reduce the likelihood of) wrong data being entered into a system.

For example, there was a program in Section 4.4 which took in a student’s exam mark and worked out their grade. Suppose a student scored 59, so should have been given a ‘B’, but the tutor was in a hurry, and the mark was entered as 599 by mistake. The computer doesn’t have any ‘common sense’, so it processes the data it is given, and awards the student an ‘A’. Garbage in, garbage out!

You could prevent this sort of error by making it impossible to enter a mark of over 100. We would describe a mark of over 100 as being **invalid**. Invalid data is data which couldn’t possibly be correct, or which doesn’t make sense in the context.

To prevent the input of invalid data, we can put the coding for input of data inside a conditional loop, that only proceeds if the data entered is valid. A conditional (If) statement can also be inserted to warn the use if invalid data is entered.

In True BASIC, it could look like this:

```
Do
INPUT prompt “Enter a mark (up to 100)”:mark
If mark > 100 then PRINT “Too high”
Loop Until mark <=100
```

- enter the code above
- add the line

PRINT “Mark “;mark to display the valid mark in the text box on the form.

Run the program to test that it prevents the user from entering an invalid mark (i.e. one that is over 100).

If you tested the program thoroughly, you might have discovered that it is still possible to enter invalid data. For example, the program would accept a **negative number**, which would not be a valid mark in any exam that I know.

We can easily adapt the program to also prevent invalid negative numbers being entered, as follows (changes in bold), using **complex conditions**:

```
Do
INPUT prompt “Enter a mark (between 0 and 100)” :mark
If (mark > 100) Or (mark < 0) Then PRINT “That was not a valid mark”
Loop Until (mark >=0) AND (mark <= 100)
PRINT “Valid Mark =”; mark
```

Make these changes and test the program again using the following test data:

Normal: 23, 55, 99, 150, –10
Extreme: 0, 100, 0.0001, 99.999, 100.001
Exceptional: A, <spacebar>

Save this program as **valid_mark**. You will use it as a basis for the tasks in Section 5.2

Validation or verification?

Notice that **input validation** doesn’t prevent **wrong** data being entered. For example, if a student had scored 55 in an exam, and the operator entered the mark as 56 by mistake, the program would accept this data.

The data would be wrong but still valid!

The process of preventing **incorrect data** being entered is called **verification**.

Many commercial data-processing systems involve both **verification** and **validation**. In this unit, we are only considering **validation**.

Standard algorithm for input validation

The coding for input validation always follows a standard pattern. The details will vary depending on the specification of the program, but the same pattern can always be used. This standard pattern saves programmers time when designing programs. A pattern like this is called a **standard algorithm**.

Here is a simple version of a standard algorithm for input validation. It involves a conditional loop and an If statement, like this:

```
Do
Prompt user for valid input
If input is invalid, warn user
Loop until input is valid
```

Adapting program 4.4

We can use the standard algorithm for input validation to improve the exam grade program we developed in Section 4.4. Here is the section of code used to input the data.

```
! store user inputs
INPUT prompt "What is the exam marked out of ":max_mark
INPUT prompt "Please enter your first name ":forename$
INPUT prompt "Please enter your second name ":secname$
INPUT prompt "What is this student's mark ":mark
```

As it is at the moment, you could enter **any** mark into the variable mark.

Let’s alter the coding so that it won’t accept the following types of invalid mark:

- no marks less than 0
- no marks greater than the maximum mark for the exam.

All you need to do is replace the single line

```
INPUT prompt "What is this student's mark ":mark
```

with an input validation loop, like this:

```
Do
INPUT prompt "Enter a valid mark ":mark
If (mark > max_mark) Or (mark < 0) Then PRINT “That was not a valid mark”
Loop Until (mark >=0) AND (mark <= max_mark)
PRINT “Valid Mark “;mark
```

Test the program to ensure that the input validation is working.

Extra task:

Change the line INPUT prompt "What is the exam marked out of ":max_mark to ensure that the user cannot enter a maximum mark less than 0 or greater than 200, by replacing it with a standard input validation loop.

5.2 Input validation tasks

Adapt the valid_mark program from Section 5.1 to do each of the following:

1. Prompt the user to enter their age.
   Do not accept ages less than 0 or greater than 120 as valid ages.

2. Prompt the user to enter a 4-digit PIN.
   The program should only accept the PIN if it is 4 digits long.
   (Hint: make it a numeric; what is the smallest and largest value?)

3. Prompt the user to enter what year they are in at school.
   Only accept 1, 2, 3, 4, 5 or 6 as valid years.

4. Prompt the user to enter their type of membership in a club.
   Membership codes are J (for Junior), I (for Intermediate) and S (for Senior).

5. Prompt the user to enter Yes or No.
   The program should accept ‘YES’, ‘Yes’, ‘yes’, ‘NO’, ‘No’ or ‘no’.

6. Prompt the user to enter a name.
   The program should only accept a name beginning with the letter ‘A’.
   (Hint: use name$[1:1])

7. Prompt the user to enter a password, which can include letters and numbers.
   The program should only accept a password that is at least six characters long.
   (Hint: use LEN)

5.3 Other standard algorithms

There are many other standard algorithms used by programmers.

For this unit, you need to:

- be able to recognise and code the standard algorithm for input validation
- know about four other standard algorithms, and understand where and when they might be used.
  (You don’t need to be able to code these other standard algorithms unless you study the Higher Software Development unit.)

The other standard algorithms you need to know about are:

- finding a minimum
- finding a maximum
- counting occurrences
- linear search.

All of these algorithms apply to a list of data items stored in a computer system. These could be lists of names, or lists of numbers (student marks, for example).

Finding a minimum

This algorithm works its way through a list of numbers, and finds the number with the lowest value. For example, here is a list of daily midday temperatures recorded at a weather station during February 2003.

date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
temperature (°C)	4	6	5	7	11	9	8	5	3	4	3	6	7	4

date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
temperature (°C)	5	6	2	3	8	6	12	10	11	9	6	11	8	6

The **finding a minimum** algorithm would search through all the daily temperatures in the list, and find the lowest one. In this case, it would be 2 °C (on the seventeenth of the month). The algorithm would return the value 2 (the actual minimum temperature).

Other examples could include:

- finding the lowest mark in a list of exam marks
- finding the winner in a list of golf scores
- finding the youngest member in a club membership list.

Finding a minimum can also be used to search a list of names to find the first if arranged alphabetically (this is possible because strings are stored as ASCII codes, which are numbers).

Finding a maximum

This algorithm works its way through a list of numbers, and finds the number with the **highest** value. In the example above, it would find 12 °C (on the twenty first of the month).

Counting occurrences

This algorithm also works its way through a list of numbers. As it does so, it counts how many occurrences of a given value there are in the list. For example, if the counting occurrences algorithm was applied to the list of midday temperatures, with a search value of 9 °C, it would return the answer 2, as there are two days (the sixth and the twenty fourth) when the temperature was 9 °C.

date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
temperature (°C)	4	6	5	7	11	**9**	8	5	3	4	3	6	7	4

date	15	16	17	18	19	20	21	22	23	24	25	26	27	28
temperature (°C)	5	6	2	3	8	6	12	10	11	**9**	6	11	8	6

Linear search

The final standard algorithm which you need to know about is called **linear search**. The idea is simple – it searches through a list looking for a particular item, and reports where the item is found.

In the above list of temperatures, if linear search were given the search value 7 °C, it would return the answer 13, as 7 °C is found at position 13 in the list.

Q1: Look at these lists of data items.

1.	27.3	1.	999	1.	0.001
2.	15.6	2.	333	2.	0.002
3.	9.93	3.	–500	3.	0.010
4.	15.6	4.	0	4.	0.100
5.	1.56	5.	299	5.	0.020
6.	28.3	6.	929	6.	0.111
7.	23.8	7.	–922	7.	0.001
8.	2.38	8.	99	8.	0.002
9.	15.6	9.	–99	9.	0.200
10.	99.3	10.	299	10.	0.120

What value would each of the following standard algorithms return (numbers in brackets refer to columns 2 and 3)?

(a) find minimum
(b) find maximum
(c) count occurrence of 15.6 (99) (0.001)
(d) linear search for 2.38 (929) (0.111).

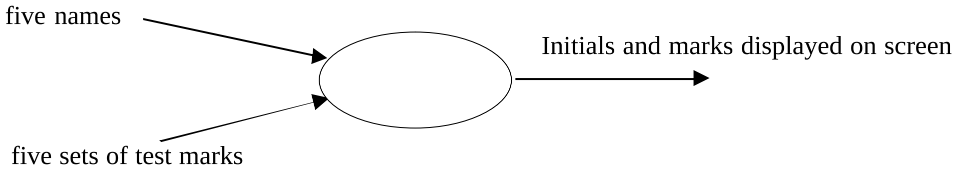
Q2: Which standard algorithm would be used by the national census organisation to:
(a) find out how many people called Mary live in the UK
(b) find out the oldest person living in the UK
(c) discover whether or not there was an individual called ‘Stan D. Ard al-Gorithm’ in the UK?

5.4 Using arrays

All of the standard algorithms which you met in the last section operate on a list of data items. In this section, we will see how a computer program can store a list of items.

Suppose a program was required which would prompt the user to enter and store the names and test marks for five students. Let's try …

Stage 1 – Analysis – data flow diagram



Stage 2 – Design

We want the user interface to look like this:

Next, we design the list of steps (pseudocode) and then the coding for the command button.

Pseudocode	True BASIC coding
1. enter and store the 1st student's name	Input prompt "Enter 1st name "first_:name$
2. enter and store the 1st student's mark	Input prompt "and their mark "first_:mark
3. enter and store the 2nd student's name	Input prompt "Enter 2nd name "second_:name$
4. enter and store the 2nd student's mark	Input prompt "and their mark ":second_mark
5. enter and store the 3rd student's name	and so on…
6. enter and store the 3rd student's mark	
7. enter and store the 4th student's name and so on …	
8. enter and store the 4th student's mark	
9. enter and store the 5th student's name	
10. enter and store the 5th student's mark	
11. display the 1st student's name and mark	Print "First name ";first_name$;" and mark ";first_mark
12. display the 2nd student's name and mark	Print "Second name ";second_name;" and mark ";second_mark
13. display the 3rd student's name and mark	
14. display the 4th student's name and mark	and so on …
15. display the 5th student's name and mark	

Variables required:
first_name, second_name, third_name, fourth_name, fifth_name (all strings)

first_mark, second_mark, third_mark, fourth_mark, fifth_mark (all numerics).

Stage 3 – Implementation

- Start a new True BASIC program
- Enter the code for the program using the variables above
- Save the program.

Stage 4 – Testing

Test the program with some normal test data.

Here is simpler version using 2 For … Next loops:

```
For i = 1 to 5
Input prompt "Enter a student's name ":student_name$
Input prompt "and their mark ":student_mark
Next i

For i = 1 to 5
Print student_name$;TAB(20); student_mark
Next i
End
```

Implement and test this new version.

You might well be thinking that this is a very tedious example, and that there should be an easier way of implementing the program …

… and you are right! You should be thinking 'Loop!' This is an ideal situation to employ a For … Next loop, as the same action has to be repeated five times.

There is a problem! The program has only stored the **last** name and mark we entered. Each name (and mark) has been stored in the same variable, each time overwriting the previous value. We need to have **different** variable names for **each** name and mark, but we can't do that within the For … Next loop.

The answer to our problem is a special type of data structure called an **array**.

Rather than using five different variables for five names, like this …

```
INPUT first_name$
INPUT second_name$
INPUT third_name$
INPUT fourth_name$
INPUT fifth_name$
```

… we can set up a name array, like this:

```
Dim name$(5)
```

and rather than using another set of five variables for the marks, like this …

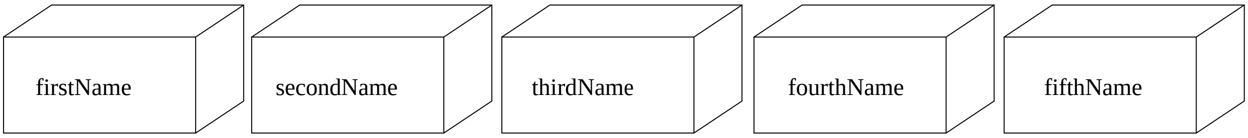
```
INPUT first_mark
INPUT second_mark
INPUT third_mark
INPUT fourth_mark
INPUT fifth_mark
```

… we can set up a mark array, like this:

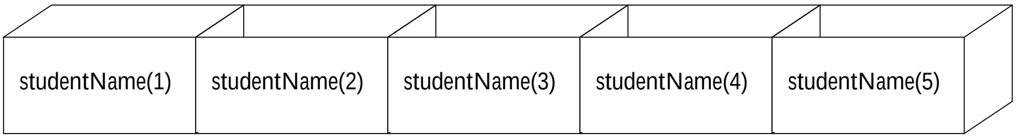
```
Dim mark(4)
```

What does **Dim name$(5)** mean?

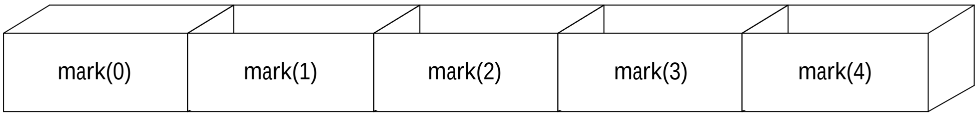
Instead of setting up five separately named variables to hold the five names



… True BASIC sets up a variable structure called an **array** that can store all five names, with each array **element** being referred to by its index number (1, 2, 3, 4 or 5).



Similarly, **Dim mark(4)** sets up an array that can store five numbers:



The really useful thing about an array is that the program can refer to the whole array at once, or to any single element.

Now let's see how using arrays lets us simplify the program we have been working on.

Here is the version that doesn't work:

```
For i = 1 to 5
Input prompt "Enter a student's name ":student_name$
Input prompt "and their mark ":student_mark
Next i

For i = 1 to 5
Print student_name$;TAB(20); student_mark
Next i
End
```

… and here is a version that does work, using arrays:

```
Dim name$(5)
Dim mark(5)

For i = 1 to 5
Input prompt "Enter a name":name$(i)
```

The first time through the loop, i = 1, so the first name and mark are stored in array elements name$(1) and mark(1). Next time, i = 2, so name$(2) and mark(2) are used, and so on.

```
Input prompt "and their mark ":mark(i)
Next i
For i = 1 to 5
Print name$(i); TAB(20);mark(i)
Next i
End
```

The same thing happens here, with i taking the values 1, 2, 3, 4 and 5 in turn, so each name and mark is printed on the screen.

Implement and test this new version. It should work correctly now.

Stages 5 and 6 – Documentation and evaluation

As usual, you should:

- print out hard copies of your form and the coding
- save your program
- write a short User Guide and Technical Guide
- write a brief evaluation of the program in terms of its fitness for purpose, user interface and readability.

5.5 Examples using arrays

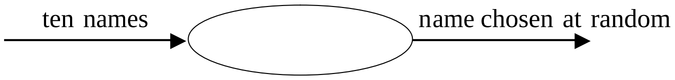
Lucky Prize Draw (version 1)

Stage 1 – Analysis

Program specification

Design, write and test a program which prompts the user to enter 10 names, then selects and displays one chosen at random.

Data flow diagram



Stage 2 – Design

We want the user interface to look like this:

Prize Draw

The lucky winner is …

The user will enter the ten names using an array and Input statements.

Next, we design the list of steps (pseudocode) and then the coding for the program.

Pseudocode	True BASIC coding
1. Do the following ten times	For i = 1 To 10
1.1 prompt the user to enter a name and store the name in an array	Input Prompt "Enter a name ":name$(i)

2. Next	Next i
3. Select a random number between 1 and 10	Randomize Let Number = …
4. Display the selected array element	Print “The winner is “;name$(Number)

Variables required:
i and number (both numeric)   name$(10) (array of strings)

Stage 3 – Implementation

- Start a new True BASIC project
- Enter the code for the program.
- Save the program.

Stage 4 – Testing

Run the program to make sure it works correctly, selecting a different winner every time. To save time, you can enter the names as Q, W, E, R, T, etc., from the top row of the keyboard.

Lucky Prize Draw (version 2)

Program specification

Design, write and test a program which prompts the user to enter four names and four prizes.

The program should select a lucky winner at random, and assign them a prize chosen at random. The program should then display the name of the winner and the chosen prize.

Work through all the stages of the software development process for this program – Analysis, Design, Implementation, Testing, Documentation and Evaluation.

Congratulations! You have completed **Section 5**.

Here is a summary of what you should now be able to do using True BASIC:

- everything from the Section 3 checklist
- everything from the Section 4 checklist
- write the pseudocode for the input validation standard algorithm
- write True BASIC coding for a standard input validation algorithm
- use complex conditions (using Or and AND) for input validation
- declare arrays
- use For … Next loops to handle arrays.

You have now completed the whole unit on software development. By working your way through all the example programs and tasks in this package, you should have demonstrated all the practical skills required to pass the unit, and have enough evidence to support this.

You should also now be ready to sit the multiple-choice NAB test for this unit.

Good luck!

ANSWERS

Section 1.1

Q1. Hardware is the items of equipment that make up a computer system.

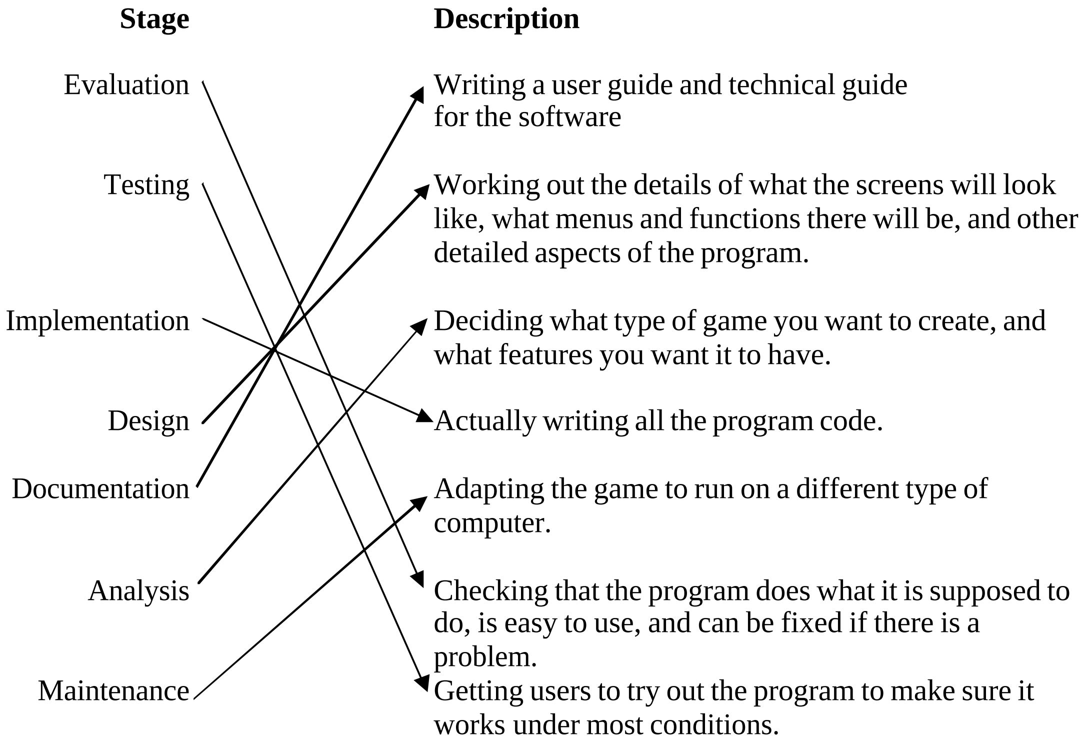
Q2. Examples of software include any application packages (e.g. Microsoft Word), any operating system (e.g. Windows 97) or any document or file.

Q3.

Item	hardware	software
monitor	✓	
database		✓
Windows 97		✓
scanner	✓	
an e-mail		✓
Internet Explorer		✓
mouse	✓	
modem	✓	
a computer game		✓
a word processor		✓
digital camera	✓	

after Section 1.10

Q1.



Stage

Evaluation

Testing

Implementation

Design

Documentation

Analysis

Maintenance

Description

Writing a user guide and technical guide for the software

Working out the details of what the screens will look like, what menus and functions there will be, and other detailed aspects of the program.

Deciding what type of game you want to create, and what features you want it to have.

Actually writing all the program code.

Adapting the game to run on a different type of computer.

Checking that the program does what it is supposed to do, is easy to use, and can be fixed if there is a problem.

Getting users to try out the program to make sure it works under most conditions.

Q2. The three criteria used to evaluate software in this unit are fitness for purpose, user interface and readability.

Q3. Both show the main steps in any process. Pseudocode is read from top to bottom; a structure diagram is read from left to right.

Q4. A User guide tells you the features of the software, how to use it, and possibly a tutorial. The Technical Guide gives information on installation and the technical specification of the computer required to run the program.

Q5. Normal, extreme and exceptional testing.

Q6. A game could have bugs fixed, or new features added.

after Section 2.1

Q1. High level is easier to understand.

Q2. High level is easier to correct.

Q3. Machine code and assembler are low-level languages.

Q4. Pascal and BASIC are two high-level languages (there are many more).

Q5. HLLs are designed to be understood by humans; LLLs are designed to be understood by computers.

Q6. HLLs are more readable, easier to fix bugs, designed for problem solving.

after Section 2.5

Q1. Interpreters and compilers.

Q2. A compiler translates a whole program before executing it.

Q3. An interpreter translates line by line.

Q4. Compiled programs run more quickly because they are already in machine code, and so don’t need to be translated.

after Section 2.7

Q1. A macro is a program to automate a process in an application; it can be activated by a combination of keys whenever it is needed.

Q2. Macros are written in scripting languages such as VBA.

Q3. They allow automation of frequently repeated complicated combinations of actions.

Q4. For automating a complex set of formatting commands in a word processor, or automating a complex query in a database.

after Section 3.1

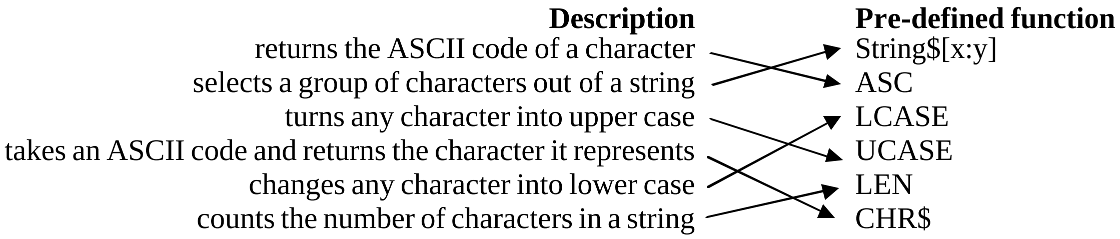
Q1. A command button, a text box, a label.

Q2. The >icon starts the execution of a program.

Q3. Clicking on a command button is a common True BASIC event.

after Section 3.12

Q1.

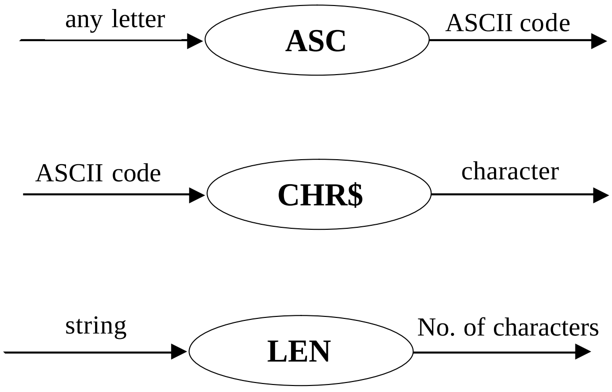


Description	Pre-defined function
returns the ASCII code of a character	String$[x:y]
selects a group of characters out of a string	ASC
turns any character into upper case	LCASE
takes an ASCII code and returns the character it represents	UCASE
changes any character into lower case	LEN
counts the number of characters in a string	CHR$

Q2.

Sentence$[1:1] – W
Sentence$[1:4] – What
Sentence$[9:2] – 25
Sentence$[19:1 – ?

Q3.



Section 4.9

(a) For counter = 3 To 36 Step 3
(b) For counter = 0 To 99 Step 9
(c) For counter = 10 To 0 Step –1
(d) For counter = 0 To 4.5 Step 0.75
(e) For counter = 50 To –50 Step –10
(f) For counter = 1 To 10 with counter^2
(g) For counter = 1 To 11 with 2^counter

Section 5.3

Q1.

	Column 1	**Column 2**	**Column 3**
Finding minimum	1.56	–922	0.001
Finding maximum	99.3	999	0.200
Count occurrences	(15.6) 3	(99) 1	(0.001) 2
Linear search	(2.38) 8	(929) 6	(0.111) 6

Q2.

(a) count occurrences
(b) finding maximum (or minimum if searching dates of birth)
(c) linear search.